An Achievement Test in Arithmetic for Standards Three to Seven in the Rural Areas of the Kolhapur District.

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A Thesis submitted to the University of Poona for M.Ed. Degree, 1956.

CONTENTS.

		Pages.
Preface.		v
Chapter.		
I	Aims and Uses of Testing.	1 - 4
	1) Instructional uses of the Test. 2) Administrative uses of the Test. 3) Uses of the Test in further Research 4) Plan of this Thesis.	
II	Development of Testing.	5 - 9
	1) Testing till the end of 1800 2) Testing in the 19th Century. 3) Testing in the 20th Century in America 4) Testing in the 20th Century in England 5) Neglect of Testing in India.	
III	Construction of the Test and the Methods of Scoring.	10 - 17
	1) Types of Tests. 2) Rate Tests. 3) Power Tests. 4) Construction of the preliminary Test. 5) Methods of Scoring the Test.	
IV	Preliminary Testing.	18 - 29
	1) Introduction. 2) Results of the preliminary Testing. 3) Construction and description of the final Test.	
V	Description of the Data collected	30 - 50
	1) Rural area selected. 2) Scores by Standards. 3) Scores by Ages. 4) Description of the Curves for Standards. 5) Description of the Curves for Ages.	
VI	Making norms to the Test.	51 - 59
	1) Introduction. 2) Grade norms. 3) Uses of the Grade Norms. 4) Age Norms. 5) Uses of Age Norms.	

Chapter.		Pages.
VII	Other Scales of Measurement. 1) The percentile Ranks. 2) The Z - Scores. 3) The T - Scores. 4) The Letter Grades.	60 - 63
VIII	The Criteria of a Good Test. 1) Reliability. 2) Validity. 3) Objectivity. 4) Administrability. 5) Interprelability.	64 - 69
IX.	Analysis of Errors in Arithmetic 1) Introduction. 2) Errors in Addition. 3) Errors in Subtraction. 4) Errors in Multiplication. 5) Errors in Division. 6) Conclusions.	70 - 87
X	The Study of the Syllabus 1) Introduction. 2) The Revised Syllabus and its Limitations. 3) Achievements of the pupils in separate processes and conclusion. 4) Placement of Topics- Research on 5) Proposed Syllabus. 6) Comparison of the Proposed and the Revised Syllabus.	88 - 111
XI	Comparison of Rural and Urban Achievement in Arithmetic. 1) Introduction 2) The problem of statistical comparison. 3) Comparison of the Means. 4) Conclusions.	112 - 116
XII	Analysis of Test Items. 1) Introduction. 2) Curricular validity of Test items. 3) Discriminating Power of the Items.	117 - 122
XIII	Suggestions for the Improvement of Teaching. 1) Introduction. 2) Uses of Tests in the Improvement 3) Suggestions for improvement.	123 - 127

PREFACE.

The present Thesis deals with the measurement in Arithmetic of rural children. Some work of the present type has been done in the case of children studying Arithmetic in the Urban schools. No achievement tests exist for the children studying in schools of Rural areas.

In the present work I am indebted to Dr. V.V.Kamat who guided me in carrying on the research. I am also indebted to Shri J. P. Naik for valuable suggestions especially on the Chapter on Error-Analysis. Last but not least I am very much indebted to the Headmasters of the Primary Schools who gave perfect co-operation in giving the tests tothe children in their schools.

Kolhapur,
MAY 1956.

S. V. Samant.

CHAPTER I.

Aim and uses of the Achievement Test.

Every teacher who undertakes to teach a subject has certain objectives to achieve. It is the aim of an achievement test to offer a standard of measurement by which a teacher may find out whether he has achieved the objectives of his course or not. When he compares the performance of his pupils with the age and grade norms set up for the test after it has been standardised on several hundreds of students, he will be able to find out whether his pupils are doing normal, superior or inferior work in the given subject as compared with that of the general population. Only after knowing the scores of the pupils on a suitable achievement test will a teacher be able to guide his pupils so as to achieve the objectives set up for his course. Unless the teacher has a measure of the effectiveness of his instruction he is likely to waste his energies, sometimes even not knowing that he is doing so. The chief aim of this achieve-ment test is to help the teacher to improve his instruction by carefully studying the results of the test.

The second important objective ofthis test is to help teachers in diagnosing the weakness of his students and then prepare a programme of remidial teaching so as to improve their work by removing their weaknesses. Though specially constructed diagnostic tests are required for this purpose,

the present test when used individually may very well be adapted for locating the chief errors committed by the students. The chapter on the 'Analysis of Errors' will be useful to achieve this purpose.

Thirdly this test proposes to study the present revised syllabus in Arithmetic. The chief aim of the framers of a syllabus is to set down the contents of the course in a given subject. This content is usually sound from the point of view of social and intellectual usage. However, the division of the total content according to standards is a difficult task. Many gaps may remain in the division when it is done quite arbitrarily. It is at this point that the test proposes to make suggestions based on objective measure-ment and a study of modern research in this field.

In the fourth place the test can be used administra-tively. It can be used to supplement the promotion of pupils from standard to standard and to classify students so as to have more homogeneous classes. This will reduce the wastage of energy caused by the individual differences existing among the students of a given standard.

Fifthly the test can be used to assess the work of teachers responsible for the teaching of arithmetic. The scores of pupils taught by different teachers through the same course can be compared and if the differences in teaching as shown by the scores on the test are found to be significant, experiments can be set up to investigate the problem.

Finally the test can be used in further research. The performance of children in different areas and different social environments can be compared and the results can be used for further improvement.

The importance of standardised tests and measurement has been pointed out by many authors. Below are given two quotations. The first is by W. C. Reavis from his book. 'The Elementary School'.

"The greatest factor in bringing the marking of pupils to an objective basis and in influencing teachers' opinion as to the value of reliable records of the achievement of the pupils is the standardised test. The uses of norms for standardised tests for purposes of comparison have been influential in making marks meaningful to teachers and parents. The results derived from standardised tests, expressed in grade scores have caught the attention of pupils giving them more confidence in examination marks and stimulating them to greater effort than did the old type examination. Teachers too have developed a new interest in the data secured from standardised tests and as a result general improvement in the measurement of the progress of the pupils has been made". (1)

Regarding measurement in Arithmetic, Bruckner, one of the foremost authorities on elementary education says.

"The value of measurement as a means of enabling the learner

(1) The Elementary School by W.C. Reavis, p. 234

learner to evaluate his experiences and to direct more effi-
-ciently the subsequent steam of his experiences is being clearly recognised. Increasingly it is becoming evident that education must be guided by a clearent underlying philosoply emphasising the growth of the learner as a well-rounded personality. The methods and materials of instruction must be selected on a well-formulated body of objectives. Tests to determine the degree to which these objectives arebeing achieved must be constructed if they are not already available". (2)

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(2) Yearbook of N.S.S.E. 1938.

CHAPTER II

DEVELOPMENT OF TESTING.

Testing is not a new thing. China had a system of testing and examination for the selection of public servants. This was even earlier than 1000 years B.C. The whole movement of testing can be divided into three periods. The first two periods namely: (1) From the beginning in China to the end of the 18th century, and (2) the period of the 19th century may be called the periods of examinations, because tests as they are defined to-day did not exist at that time. During the first period the examination was really a very crude affair. Even during the second period the personal bias of the examiner was quite marked. However some serious efforts were made to improve this condition by men like Horace Mann in America and Rev. George Fisher in England. In fact, the credit for using the first objective examination goes to Rev. George Fisher who used his 'scale books' in the Greenwich Hospital school as early as 1864. The second period may be called the semi-scientific period. The end of this period was influenced by the scientific and statistical work of Karl Pearson and Galton in England and Binet in France.

The third period, roughly beginning with the opening of the 20th century, can be called the scientific period. It begins with the publication of the investigation of Dr. J.M. Rice, of the spelling achievement of thousands of children

using

using a test of 50 spelling words. Dr. Rice analysed his results and planned educational procedures based on his findings. He published his results in the Forum, a journal edited by him.

Dr. Rice published his work in 1897 but his idea did not become popular. The real impetus to the movement of testing came after the turn of the century. It was in 1904 when E.L.Thorndike published his epoch-making book, 'An Introduction to the Theory of Mental and Social Measurement' in 1904. This was the first book of its kind and provided the research workers with a knowledge of procedures required for procuring and interpreting educational achievement.

The first standardised Achievement test was devised by Stone, a pupil of E.L.Thorndike. This test was published in 1908. In 1909 S.A.Courtis published his test to measure achievement in Arithmetic. Thorndike handwriting scale appeared in 1910. During the period of 1909 to 1915 a series of tests for the measurement in Arithmetic, composition, spelling, drawing and handwriting were published. From 1917 the development of tests was so rapid that, by 1928, just two decades after the movement began, nearly 1300 standardised tests were catalogued. In 1940 similar unpublished account exceeded 2600.

Educationists derided the standardised tests in the beginning. However, the construction and the spread of the tests continued chiefly for three reasons. Firstly, the numerous important studies of the subjective nature of

traditional

traditional type of examination demonstrated the need for devices for more accurate measurement of educational achieve--ments. Secondly, the survey of large school systems, both stimulated the construction and the use of tests and were influenced by the development of more objective devices for measurement. Finally, the development of educational measurement of the research departments organised in many of the school systems and state departments of public instruc--tion popularised the use of standardised tests.

In the beginning of the movement the tests were used in the primary schools only. As time went on the tests began to be used in the high schools as well as the colleges. A large number of tests were designed specially for the high-schools and the colleges.

In 1936 the Progressive Education Association of the U.S.A. started an experiment for the investigation of the relationships between the colleges and schools. The staff appointed for the evaluation of the results of the study, known as the 8 year study, comprising 30 schools, under the leadership of Dr.Tyler, devised a large number of tests for measuring the achievement of children at different levels. Theirs is undoubtedly the broadest coordinated attack upon the evaluation and appraisal of all types of instructional outcomes by the use of test procedures and related scientific techniques that have ever been undertaken.

In America the use of achievement tests is so common that Dr.L.J.Brueckner and Dr.F.E.Grossnickle in their recent

book

book 'How to make Arithmetic Meaningful' list the following eleven tests frequently used by school systems to measure the achievement in Arithmetic. They are:

(1) Analytical scales of allainment in Arithmetic, Grades III to VIII, Minueapolis Educational Test Bureau.

(2) Bruckner L.J. Coordinated scales of Attainment in Arithmetic, Grades I to VIII.

(3) Brueckner L.J., Progress Tests in Arithmetic Processes; Grades III to VIII.

(4) Brueckner L.J, Progress Tests in Problem Solving. Grades III to VIII.

(5) Iowa Everypupil Test in Basic Arithmetic Skills; Grades VI-VII-VIII.

(6) Metropolitan Achievement Test; Grades II-VIII

(7) Modern School Achievement Tests; Grades II-VIII. Columbia University.

(8) New Stanford Achievement Test; Grades II-IX, Test or processes and problems.

(9) Progressive Achievement Tests; Grades IV-VI.

(10) Progressive Achievement Tests, Grades VII-IX Los Angeles.

& (11) Unit Scales of Attainment; Grades I -IX, Minueapolis Educational Test Bureau. (3)

It is very important to note that almost all the great American educationists like E.L.Thorndike; Terman; F.B.Knight; L.J.Brueckner; C.W.Washburne; G.M.Wilson and H.A.Greene have been responsible in building the above tests. This fact shows the importance and value of testing.

In

How to make Arithmetic Meanin[illegible]

In England too, educationists like Dr.P.B.Ballard and Dr.Cyril Burt have devoted themselves to the problem of the construction of tests and the best known Arithmetic test in England, namely, the Northumberland Arithmetic Test is the work of the latter.

India also has done some work in this field. E.W.Menzel has described one achievement test in his book, 'New Tye Tests and Their Uses in India.' The second test of this kind is the one standardised by Shri Gothivrekar for his M.Ed. Thesis in 1937. This is a restandardisation of the Northumberland Test of Dr.Cyril Burt on an Indian Sample.The third and the last test of this type is developed in his M.Ed. thesis for 1941 by D.V.~~S~~ Chickermane in 'Studying the Arithmetical Abilities of Kannada Children in Urban Areas.'

CHAPTER III.

CONSTRUCTION OF THE TEST AND THE METHODS OF SCORING.

The development of testing that has been briefly described in the last chapter progressed chiefly along three lines; (1) Mental Testing which mainly consisted of the test--ing of intelligence; (2) Aptitude Testing which consisted of testing the special aptitude for a guidance to a special m vocation; (3) Educational Testing which concerned itself with the testing of the various fields of subject matter, taught in the schools and colleges.

The educational tests were again divided into two classes; (1) Informal tests and (2) The Standardised tests. The former, usually constructed by the class teachers do not possess norms while the latter, usually constructed by research workers and specialists possess norms.

Research workers have used different methods in framing the tests. In one kind of a standardised achievement test a large number of items of equal difficulty is used. The number of items is such that even the brightest children are not able to finish the whole test in the prescribed time. Such a test is called a 'rate test' and the number of items correctly solved gives the score of the pupil for that particular test.

In a second variety the test may contain items arranged

in

in an ascending order of difficulty from the very easy to the most difficult for example, a test in division may consist of 20 items starting from the very easy items requir--ing the use of the tables upto 20 and ending in the most difficult items consisting of all difficulties with respect to the zero in the divisor the dividend and the quotient. Such a test measures the pupils abilities to do more and more difficult sums. The pupil who solves a sum mf Of higher difficulty has mastered the process of division to a greater extent than the pupil who solves the sum of a lower difficulty For example if a pupil makes a mistake on the tenth example his mastery of the process Of division is up to the nineth example. Similarly for the pupils who make their first mistake on the 15th or the 18th example, their achievement is that of the 14th and the 17th sum respectively. The examples solved correctly after the first mistake are not counted. This does not appear to be a good method of constructing a test for the reason that it does not make any allowance for a chance mistake committed by the student.

As an example of a third method mention may be made of the Iowa Everypupil Test of the Basic Skills in Arithmetic. In this test the items are not seperated in the four processes of addition, substraction multiplication and division as in the case of the other two methods described above. All the items are taken up together and then arranged in an ascending

order

order of difficulty. The following extract from the test illustrates this method of constructing the test.

Extract from the Iowa Everypupils Test of the Basic Skills in Arithmetic.

41 Add

736
618
422
907

42 Substract

4001
3392

43 Multiply

689
900

44 Divide

73)1491

45 Add

38
16
80
40
58
82
9
5
48
44

46 Subtract

3811
2045

47 Multiply

3070
208

48 Divide

87)4265

49 Add

$\frac{5}{6}$
$\frac{5}{6}$

50 Subtract.

32
$5\frac{7}{8}$

51 Multiply

$\frac{3}{5} \times \frac{1}{4}$

52 Divide

$6 - \frac{2}{3}$

53 Add

$5\frac{3}{8}$
$3\frac{4}{5}$

54 Subtract

$7\frac{1}{3}$
$6\frac{2}{3}$

55 Multiply

$15 \times 3\frac{2}{33}$

56 Divide

$\frac{3}{8} - \frac{1}{4}$

57 Add

$2\frac{7}{8}$
$\frac{3}{5}$
$4\frac{3}{8}$

58 Subtract

$14\frac{3}{4}$
$7\frac{1}{10}$

59 Multiply

$2\frac{1}{3} \times \frac{5}{6} \times 4\frac{2}{5}$

60 Divide

$4\frac{1}{5} - \frac{3}{8}$

61 Subtract.	62 Subtract	63 Divide
$9\frac{2}{5}$	15	$5\frac{2}{3} - 6\frac{3}{8}$
$\frac{5}{9}$	$12\frac{3}{4}$	

This type of test is found to be very difficult by children because the processes of arithmetic are mixed up and these too quite irregularly as can be seen from items number 61, 62 and 63. The students confuse the processes and add mix instead of subtracting and make similar mistakes in the other processes. This is found to be the case when it was actually used with the students of the 6th, 7th and the eighth standard. This method may be useful with high-schools and colleges where the understanding of the students is quite mature; but it is quite inadequate for pupils in the primary schools.

In what seems to be the best type of construction of the test and which is followed by me all the items are grouped into addition, subtraction, multiplication, division and problems and each subtest is so arranged so that their items go on increasing in difficulty by a smooth gradation. When a test is constructed in this way and a suitable time limit is placed on each subtest, it is found to be very serviceable to young children because all the items in the subtest are of one process only. In this way a time-limit is set up for each subtest and the items are arranged in the ascending order of difficulty, thereby combining the

merits

merits of a rate test and a power test.

In selecting the items for the five subtests construct-ed by me use was made of the syllabus of Arithmetic of the Bombay State and a large number of text-books based on the syllabus. The sample of items was discussed with some head-masters of primary schools, and then the items were arranged in an ascending order of difficulty. The following tests also were referred to for the purpose of constructing the items of the test.

(1) The Essential Mechanical Arithmetic Test For pupils 7 to 11 ; prepared by Prof. Fred J. Schonell, PH.D., D.Lit.

(2) Mohroe's Standardized General Survey Arithmetic Scales.

(3) Scale for Problems in Arithmetic First division (Grades 3 and 4) Form 1; by B.R. Buchingham.

(4) Sangven - Reidy Survey Tests in Arithmetic by Paul V. Sangren and Ann Reidy.

(5) Wisconsin Inventory Tests in Arithmetic Devised by Worth J. Osburn.

After the construction of the tentative test (See Appendix 1), p128 there arose the problem of scoring the test items This problem has to be faced because all the items in a subtest are not of approximately equal difficulty as in a rate test. The scoring of the items of an achievement test can m be made by one of the three methods described below.

The first method consists of dividing the test into different

different subtests and items in each subtest may be given equal scores. The first subtest may be given one point for each item, the second subtest two points for each item and so on for all the subtests.

This method of scoring is used in Monroe's 'Standardized General Survey Arithmetic Scales'. The weightages given in these tests are as follows.

1st test - score = no.right ÷ 3
2nd test - score = no.right
3rd test - score = no.right x 2

This method demands a very great care on the part of the scorer and the chances of committing mistakes in the scoring are proportionately great.

In the second plan various items in the test are given different scores and the sum of the scores is taken as the final score of the pupil. This method is used in the Northumberland Standardized Tests in Arithmetic constructed by Dr. Cyril Burt. His scoring is illustrated below.

Test I Addition.

No.	Answer	Score
1	79	2
2	239	2
3	19s 11 1/2d	3
4	14 ft 10 in.	2
5	16 lbs. 14 Oz.	2
6	267	2

No.	Answer	Score
7	3536	3
8	£. 21 15 S. 10½ d.	6
9	19 Yds. 1 Ft. 6½ In.	4
10	25 Tons 11 Cwt. 2 Gr.	4
11	21 5/16	2
12	131.775	5

This method of giving different weightages to differentitems creates so much clerical work for the scores that the method has a doubtful utility.This is particularly so because the weightages that could be given for the various items are allotted rather arbitrarily and not by any scientific method.

The third method of scoring consists of giving one point for each correct response and taking the total as the score of the pupils performance. This has been found to be the simplest method. Dr.Chickermane's method of scoring was similar. Recent researches in various fields of achievement favour this method as seen from the following statement. "Though it is reasonable to assume that the validity of a test will be greater if the difficult items are given more credit than is given to easy items, Carter in his researches found that when the number of items is large there is very little difference between the ranks of scores based on weighted and unweighted items. Other investigators have reported a correlation of from .97 to .99 between

weighted

weighted and unweighted scores. It is agreed generally that the validity of a test can be increased very little, if any, by weighting the items". (4)

In scoring this test therefore each correct response has been given a score of one point.

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(4) Dr. Cook. Encyclopedia of Educational Research. P.1298.

CHAPTER IV.

PRELIMINARY TESTING AND THE CONSTRUCTION OF THE FINAL TEST.

Preliminary testing is necessary to find the suita-bility of the test items for the standards for whih they are to be used. It is necessary to know whether the time set for each subtest is suitable or otherwise as well as to know whether the items are very easy or very difficult. This was more particularly the case because the test was meant for rural children who are very backward in reading and writing, as three or four classes are managed by a single teacher in x many rural schools.

The preliminary testing was carried on in the Bavda Mahal. The schools in this area carry on their work in the summer vacation because they get their vacation in the rainy season.

The test had five parts. Each part contained 20 items. The time for the tests in addition and subtraction was 7 minutes each. The time limit for multiplication and division was 8 minutes and that for the test on problems was 10 minutes. The time set for the subtests of addition multiplication, division and problems was found to be suitable. Only 2 or 3 students out of nearly 40 could come to the end of each subtest.

subtest. In the case of the subtraction test however 4 students could finish the test in less than 7 minutes.

It was further found that the examples on denominate numbers were found to be difficult by the children. Only 4 students out of 35 in the 7th standard got the multiplica-tion sums right. The division examples were attempted by 3 students only but nobody solved them correctly. The examples on common fractions and decimals were satisfactorily solved by those who tried them.

The results of the preliminary testing are shown in table number 1.

Table No. I.

Results of Preliminary Testing.

Operation	Standard.	Average of examples.		Maximum examples	
		Solved	Right	Solved	Right.
Addition	3	7.5	5.9	11	10
	4	8.1	6.8	14	14
	5	10.3	8.1	15	14
	6	13.9	10.4	19	16
	7	15.6	12.1	20	17
Subtraction	3	6.9	5.1	13	11
	4	8.0	6.7	14	13
	5	10.1	8.1	20	11
	6	13.3	10.2	20	13
	7	15.2	11.9	20	17

Table No. I (Contd).

Operation	Standard.	Average of examples.		Maximum examples.	
		Solved	Right.	Solved	Right.
Multiplication	3	7.1	5.2	14	10
	4	8.3	6.3	13	10
	5	10.0	7.9	15	10
	6	13.1	10.1	16	12
	7	14.8	11.6	16	14
Division.	3	6.2	4.1	12	7
	4	7.3	5.3	12	9
	5	9.2	6.4	12	9
	6	12.8	9.3	15	9
	7	14.4	10.6	18	11
Problem.	3	5.0	2.8	10	5
	4	8.0	3.9	12	9
	5	10.0	7.3	13	10
	6	13.6	9.2	16	11
	7	16.0	11.2	18	15

In order to remove the difficulties of timing in subtraction and that of denominate numbers the following changes were made in the final test keeping the number of items in each subtest as 20.

1) In

1) In the subtraction subtest the number of combina-tion was increased by increasing the digits in the numbers forming the examples. The difficulty of the examples was also increased by increasing the number of zero combinations and borrowing.

2) Two of the three multiplication examples in mixed numbers were made more simple by making the multiplie$r a smaller number.

3) All the three division examples in the denominate numbers were made easier by keeping the divisors such that the work may be simple and straight forward.

The final form of the test is given below. (Appendix II) p-13

The number of children examined in the preliminary test is

Std.	No. of children.
3	54
4	48
5	50
6	41
7	35
Total	228

The Achievement Test in Arithmetic.

(For Standards 3 to 7)

Directions.

1) Do not turn over this page until you are told to do so.

2) There are five sub-tests. The first and the second take seven minutes each; the third and the fourth take eight minutes each and the fifth takes ten minutes.

3) Begin with the first sub-test when you are told to do so. As soon as you are warned, begin the second. In this way do the sums until the test is over.

4) You must not ask questions while solving the sums. If you cannot solve any of them, leave it and try the next.

5) Write down the fractions in the lowest ratio. The improper fractions should be converted into the mixed ~~fractions~~. numbers.

6) Fill up the blanks in the follwoing:

Name

Caste Birth-date.

Standard Age: Years Months

School.

Village

Father's or Guardian's name

His profession.

Add. Sub-test I. Time: 7 Minutes.

(1) (2) (3) (4) (5) (6)

(1)	(2)	(3)	(4)	(5)	(6)
5	6	5	11	18	5
+ 3	+ 4	+ 6	+ 4	+ 16	3
					+ 4

(7) (8) (9) (10) (11)

(7)	(8)	(9)	(10)	(11)
36	34	508	4309	6
+ 24	+ 29	+ 423	+ 7183	48
		+ 747	+ 5964	462
				93
				+ 3

(12)

Rs.	As.	Ps.
15	4	7
+ 13	14	9

(13)

Yds.	Ft.	In.
4	1	9
+ 3	2	7

(14)

Hs.	Ms.	Sec.
4	15	30
+ 2	50	40

(15) $\frac{2}{7} + \frac{3}{7}$

(16) $7\frac{1}{3} + 6\frac{1}{4}$

(17) $7\frac{1}{4} + 4\frac{1}{3} + 2\frac{1}{5}$

(18)

(18)
7.25
+ 8.14

(19)

(19)
.41
+ 3.8
+ 1.019

(20)

(20)
3.92
+ 7.54
+ 2.78

Subtract. Sub-test II Time: 7 Minutes.

(1)	(2)	(3)	(4)	(5)	(6)
6	11	23	27	40	47
-2	- 5	- 13	- 14	-16	- 28

(7)	(8)	(9)	(10)	(11)
137	140	761	937	7508
- 28	- 17	- 112	- 482	- 829

(12)

Rs.	As.	Ps.
7	- 3	- 8
- 2	- 11	- 10

(13)

Yds.	Ft.	In.
7	- 1	- 8
- 2	- 2	- 10

(14)

Hs.	Ms.	Sec.
3	- 19	- 40
- 1	- 40	- 50

(15) $\frac{8}{9} - \frac{2}{3}$

(16) $5\frac{1}{8} - 2\frac{3}{4}$

(17) $17 - 9\frac{3}{7}$

(18)	(19)	(20)
.86	8.48	322
- .46	- .59	- 44.03



Multiply. Sub-test III. Time: 8 Minutes.

(1)	(2)	(3)	(4)	(5)	(6)
3	4	6	7	4	10
x 2	x 3	x 4	x 5	x 9	x 4

(7)	(8)	(9)	(10)	(11)
13	16	17	550	4087
x 6	x 8	x 9	x 37	x 56

(12)

Rs.	As.	Ps.
7	6	8
		x 6

(13)

Yds.	Ft.	In.
3	2	8
		x 8

(14)

Hs.	Ms.	Sec.
2	50	40
		x 9

(15) $12\frac{3}{12} \times \frac{4}{9}$

(16) $4 \times 2\frac{7}{8}$

(17) $7\frac{1}{3} \times 5\frac{1}{3}$

(18)	(19)	(20)
4	7.29	.043
x .5	x 1.8	x 25

Divide Sub-test IV. Time: 8 Minutes.

(1) 2) 8

(2) 3) 15

(3) 6) 42

(4) 9)72

(5) 11) 132

(6) 14) 364

(7) 18) 658

(8) 4) 432

(9) 400) 295600

(10) 17) 359

(11) 75) 375225

(12)

Rs.	As.	Ps.
5)	9 -	13 - 6(

(13)

Yds.	Ft.	In.
15)	22 -	2 - 9(

(14)

Hs.	Ms.	Sec.
12)	15 -	10 -36 (

(15) $\frac{5}{4} \div \frac{7}{8}$

(16) $\frac{3}{5} \div 4\frac{1}{10}$

(17) $7\frac{1}{2} \div 5$

(18) 7) .854 (

(19) .06) 1.452 (

(20) 7) 5.4036 (

Sub-test V. Time: 10 Minutes.

Solve the examples and write down your answers in the space kept.

(1) Rama has 5 marbles and Hari has 7 marbles. How many marbles have they both together? (1)

(2) I have 4 mangoes and my brother has 9 mangoes . How many more mangoes has my brother than I have? (2)

(3) There are 40 fruits. 8 of them are mangoes, 13 are guavas and the rest are bananas. How many bananas are there? (3)

(4) One bag holds 6 coconuts. How many bags are required to hold 30 coconuts? (4)

(5) Govinda has 25 rupees. He gets 45 rupees more. How many has he now? (5)

(6) There are 20 boys. How many Rupees and annas will be required if 3 annas are given to each? (6)

(7) I have 40 rupees. I give 4 rupees to each of the seven boys. How much have I left? (7)

(8) What is the cost of 24 books if one book costs 8 annas? (8)

(9) There are 35 boys in a class. They each have six note-books. How many note-books have they all together? (9)

(10) If 4 rupees are divided into three equal parts, how much does each part contain? (10)

(11) I buy 24 nuts at 8 for 1 anna. How much will that cost? (11)

(12) A boy was 15 years old in 1950. In what year was he born? (12)

(13) Find the cost of one book if a dozen books cost Rs.4 As. 8? (13)

(14) Hari has a rope 1 foot 4 inches long. Suresh has another rope 4 times as long as Hari's. What is the length of Suresh's rope? (14)

(15) A bag contains 4 lbs. of sugar. Another bag contains 2 pounds more than the first one. How many pounds do both of them contain? (15)

(16) Find the number of pages of 24 books if each one contains 145 pages. (16)

(17) 12 Shirts cost 45 rupees. How much do 16 shirts cost? (17)

(18) A square room is 16 square yards in area. What is the perimeter of the room? (18)

(19) A boy bought 180 marbles at 2 annas a dozen. He sold them at the rate of a pice per marble. What was his gain? (19)

(20) One half of a number is subtracted fromthe three-quarters of the same number, and the result is 15. What is the number? (20)

The special features of the above test are :

(1) It can be given in one school period as total time for the test is 40 minutes.

(2) It can be very easily administered as the directions to the students are clear and specific and the time limits are clearly stated.

(3) It can be scored very easily and rapidly. The method of scoring is quite objective. The objectivity of the test is described in detail in Chapter VIII.

(4) The reliability and the validity of the test are very high. They are discussed in detail in Chapter VIII.

(5) It possesses both the grade and the age norms, which can be easily interpreted.

(6) The test is printed so that it should be quite cheap as well as attractive. It's price is about nine pies and can be easily used by the schools. At the same time the test is printed in a legible and pleasing style.

CHAPTER V.

DESCRIPTION OF THE DATA COLLECTED.

This test is constructed for the measurement of the achievement in arithmetic of the rural school children in the district of Kolhapur. The sample selected consists of pupils selected from five Talukas of the Kolhapur District. The five Talukas are:(1) Bhudargad, (2) Hatkanangale, (3) Kagal, (4) Shirol and (5) Radhanagari.

The test was given to pupils in 38 schools (See AppendixIII) from 34 villages in the area. In all 3427 pupils from schools in the villages and 292 pupils from an urban centre - Jaysingpur - from the same area are tested. One urban school was selected so as to make a comparison of the results of the same test on both rural and urban children. Six of the 38 xx schools were girls' schools. The total number of girls examined was 334. The total of 3719 children examined is shown in the following table, according to their standards.

Table No. II

Table showing the number of pupils by standards.

Standard.	Rural	Urban	Total.
3	740	73	813
4	865	76	941
5	662	57	719
6	560	49	609
7	600	37	637
Total	3427	292	3719

Table No. III.

Table showing the scores by standards.

Class - Interval.	Standard					
	3	4	5	6	7	Total.
96 - 100						
91 - 95					1	1
86 - 90					3	3
81 - 85				1	10	11
76 - 80			1	6	19	26
71 - 75			4	13	45	62
66 - 70			8	38	95	141
61 - 65		1	25	71	125	222
56 - 60		5	64	116	108	293
51 - 55	2	21	122	107	88	340
46 - 50	5	90	164	101	58	418
41 - 45	22	200	137	65	26	450
36 - 40	66	192	70	21	12	361
31 - 35	109	139	38	15	6	307
26 - 30	90	90	14	4	4	202
21 - 25	113	55	10	2		180
16 - 20	119	37	4			160
11 - 15	87	19	1			107
6 - 10	79	14				93
1 - 5	48	2				50
Total	740	865	662	560	600	3427

The classification of the children according to ages per standard was then tabulated. The next table shows the number of pupils of each chronological age in each of the five standards. The statistical constants of the various age groups are shown at the bottom of the table.

Table No. IV

Table showing the number of children of each chronological age in each standard.

Chronological age.	Mid-point.	Standards.					
		3	4	5	6	7	Total
6	6.5	3					3
7	7.5	40	1				41
8	8.5	112	34	3			149
9	9.5	200	102	21	5		328
10	10.5	163	207	87	17	1	475
11	11.5	109	212	120	43	22	506
12	12.5	63	160	124	102	58	507
13	13.5	33	72	130	111	84	430
14	14.5	12	39	84	106	140	381
15	15.5	4	14	56	82	141	297
16	16.5	1	7	18	55	96	177
17	17.5		2	4	16	36	58
18	18.5		1	3	13	22	39
	Total.	740	851	650	550	600	3391

Statistical constants of the Distributions by ages, of pupils in different standards.

	Standards.				
	3	4	5	6	7
Q_1	8.0	10.4	11.4	12.7	13.8
Md	10.1	11.4	12.7	14.0	15.0
Q_3	11.4	12.7	14.0	15.5	16.1
M	10.3	11.5	12.8	14.0	14.9
	1.6	1.5	1.5	1.6	1.5
Skewness	.375	.02	.02	0	-.02

The table shows that the ages of the pupils range from 6 + to 18 + . Out of a total of 3427 students the ages of 3391 students were available. The birthdates of 36 pupils could notbe obtained as some of the students were new and they were not admitted for want of the leaving certificate. The significant age groups in each standard are marked in the table. For example in the third standard the significant age groups are those of 9, 10 and 11 years respectively. These groups increase approximately by one year according to the standard.

The average ages of the 3rd to the 7th standards are 10.3, 11.5, 12.8, 14 and 14.9 years respectively. The rise in age for every standard is slightly more than 1 year. In the 7th standard it is slightly less than 1 year i.e..9 year

In







In tabulating the scores by ages the first three i.e. 6, 7 and 8 years and the last three i.e. 16, 17 and 18 years were omitted as the number of students was considerably small and the results calculated from them would not be very reliable. The scores for the age groups 9+ to 15+ are shown in the adjoining table. Thin statistical constants are also shown.

Table No. V.

Table showing Scores of pupils by ages.

Class Int.	Ages							
	9	10	11	12	13	14	15	Total
91-95					1			1
86-90			1	1	1	1	1	5
81-85			1	2	2	1	1	7
76-80	1	1	3	7	5	6	3	26
71-75		1	6	5	10	13	14	49
66-70	2	4	10	20	26	36	23	121
61-65	2	7	14	31	27	37	47	165
56-60	3	18	16	47	50	68	52	254
51-55	7	22	34	58	53	56	56	286
46-50	24	40	68	61	68	51	49	361
41-45	32	58	77	81	56	50	25	379
36-40	49	59	83	48	50	29	14	332
31-35	31	78	60	50	26	21	12	273
26-30	26	58	39	36	19	2	3	183
21-25	38	45	37	22	7	6	3	161

Table No. V (Contd).

Class Int.	Ages. 9	10	11	12	13	14	15	Total
16-20	50	36	23	17	2	4		132
11-15	22	22	14	12	7	2		79
6-10	13	20	13	8	4	2		60
1- 5	18	8	7	5	1	1		40
Total.	318	475	506	511	415	386	303	2914
M	28.4	33.7	38.6	43.5	48.0	51.5	54.3	
Md	29.0	34.3	39.0	43.6	48.4	52.8	54.3	
	14.5	13.7	14.5	15.1	14.2	13.4	11.1	
Skewness	.1	.05	- .1	- .02	- .1	- .3	- .01	
Kurtosis	.28	.26	.26	.25	.26	.26	.26	

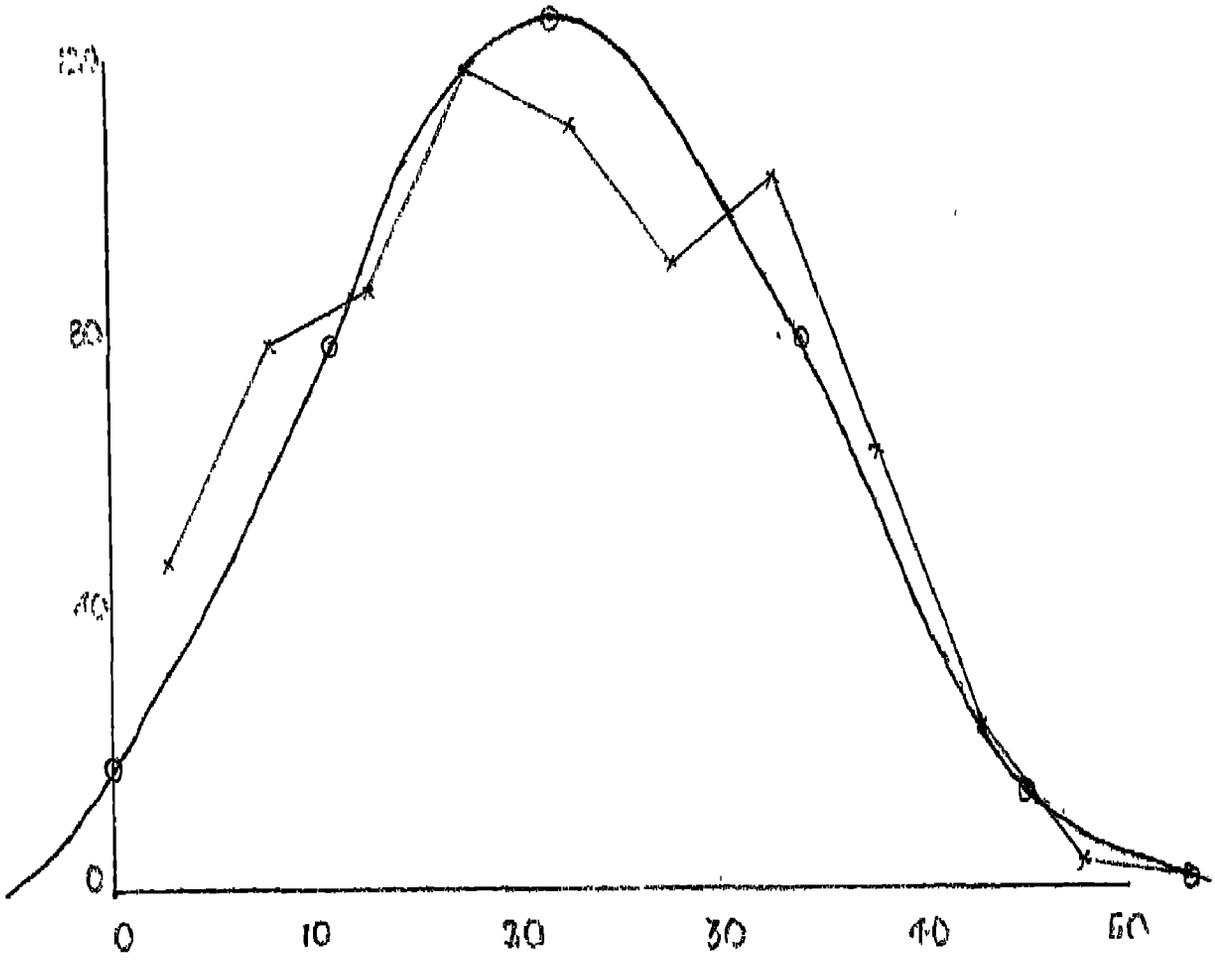
The pupils tested have been grouped according to their standards as well as according to their ages. By standards there are five groups from Standard 3rd to Standard 7th. Age groups of 9 years to 15 years only are considered. There are two reasons for omitting the age groups of 8 + and below as well as of 16 + and above. The first reason is that the number of pupils in those age groups is small and statistics based on them will not be quite reliable. Secondly the lower age groups consist of bright children

and

and the higher age groups consist of more dull children and the sample ceases to be a truly representative sample. Thus in all there are 12 groups, 5 for standard and 7 for ages.

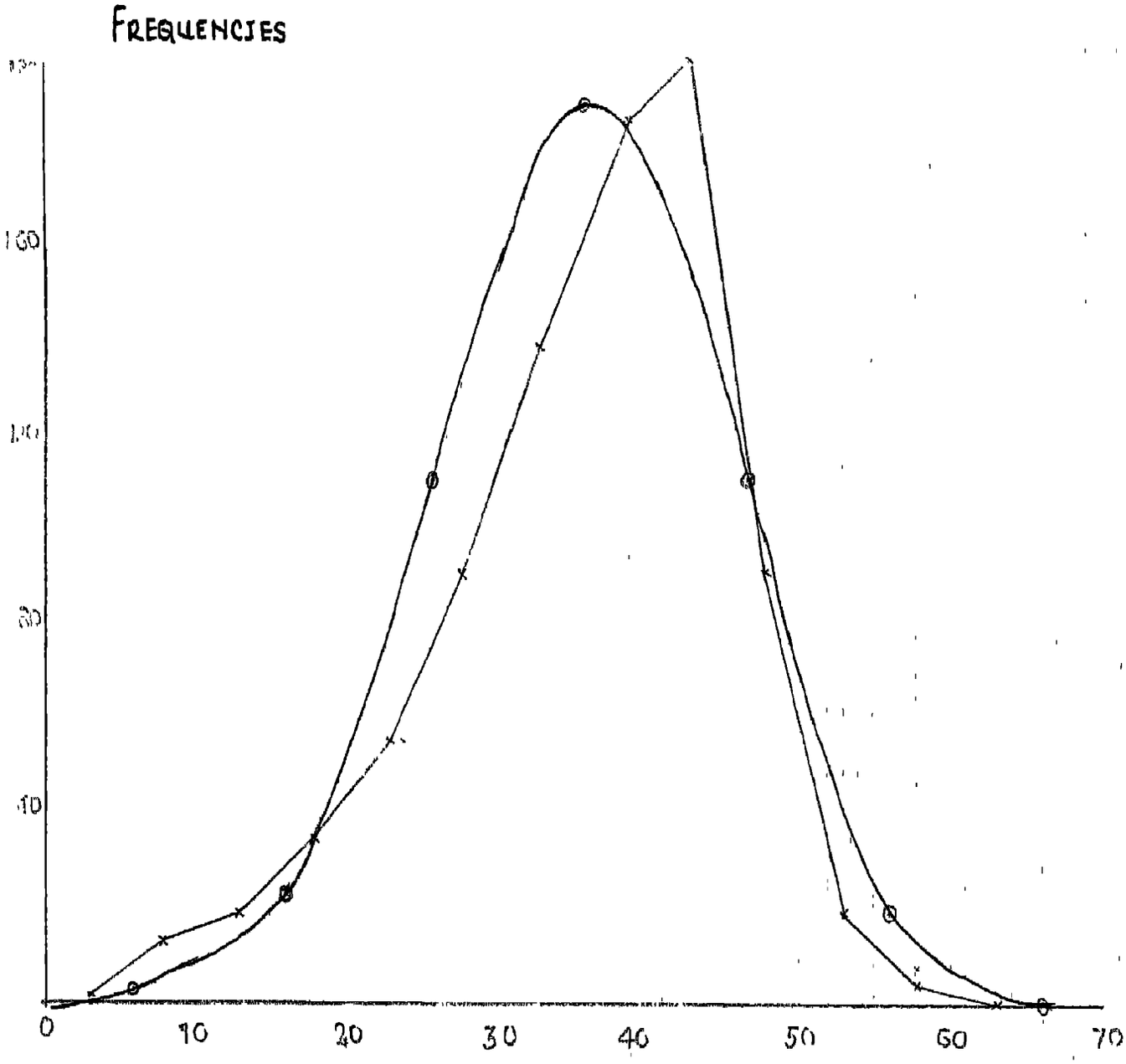
In the following description the actual conditions are compared with the conditions if they followed the law of the normal curve. Actual conditions are shown by curves in pencil and the normal curve is shown in ink.

FREQUENCIES.



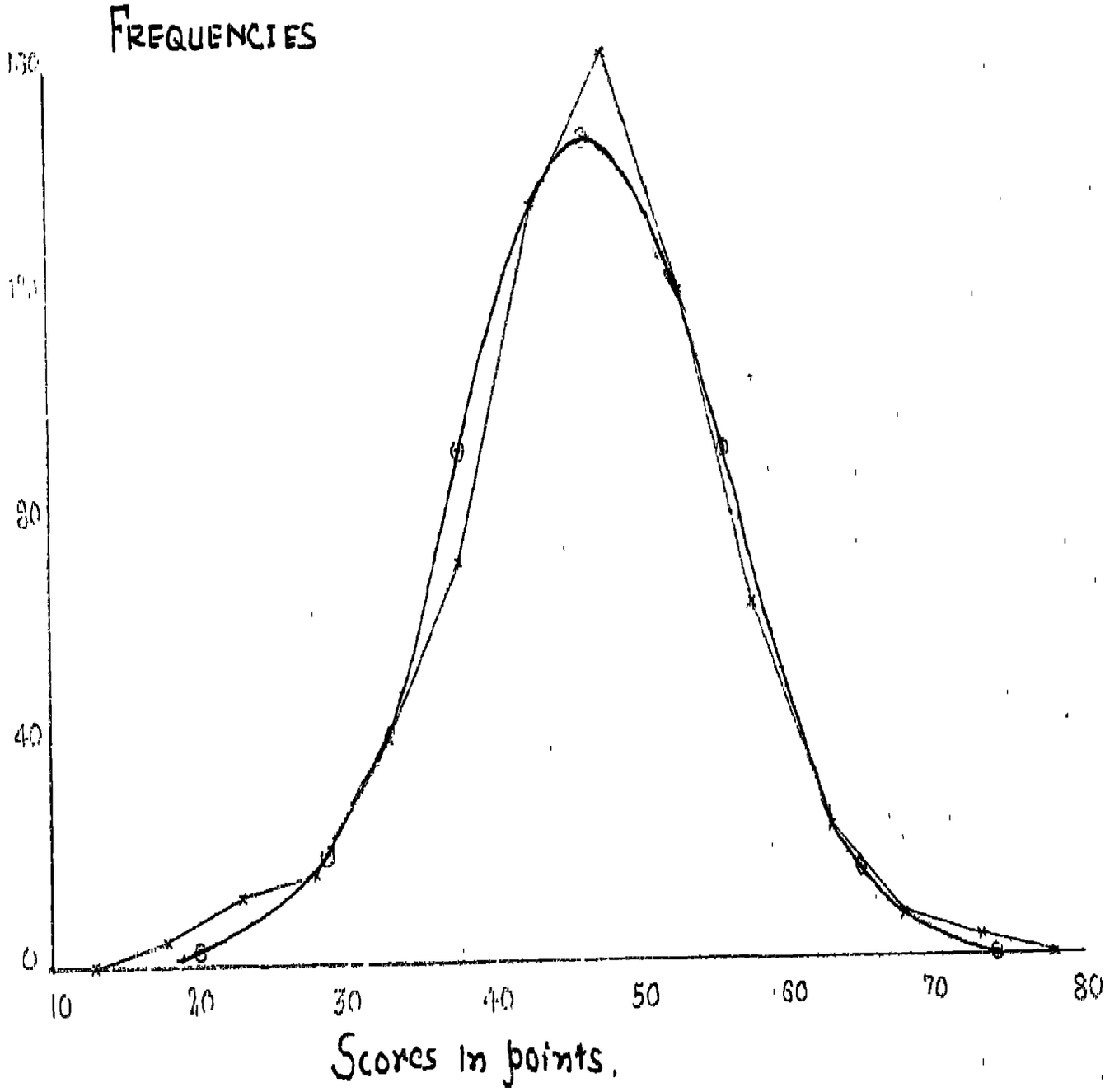
FREQUENCY CURVE FOR STD 3. [Table no. IV]

The curve for standard 3 has a mean of 21.7, a median of 22.3, Q = 8.8 and a standard deviation of 11. It is negatively shewed to a considerable extent its skewness being - 1.07 and a standard error of skewness equal to .55 . This skewness is significant. The kurtosis of this curve is .293 and a standard error of kurtosis equal to .01. The deviation from the kurtosis of the normal curve is .03 because the kurtosis of a normal curve is .263. This kurtosis is very significant as the ratio of the standard error to the kurtosis is about 3. The curve therefore deviates from the normal curve very much. The chief reason may be the fact that the children of the third standard are not accustomed to reading and writing and the test requires both the skills to a considerable extent.



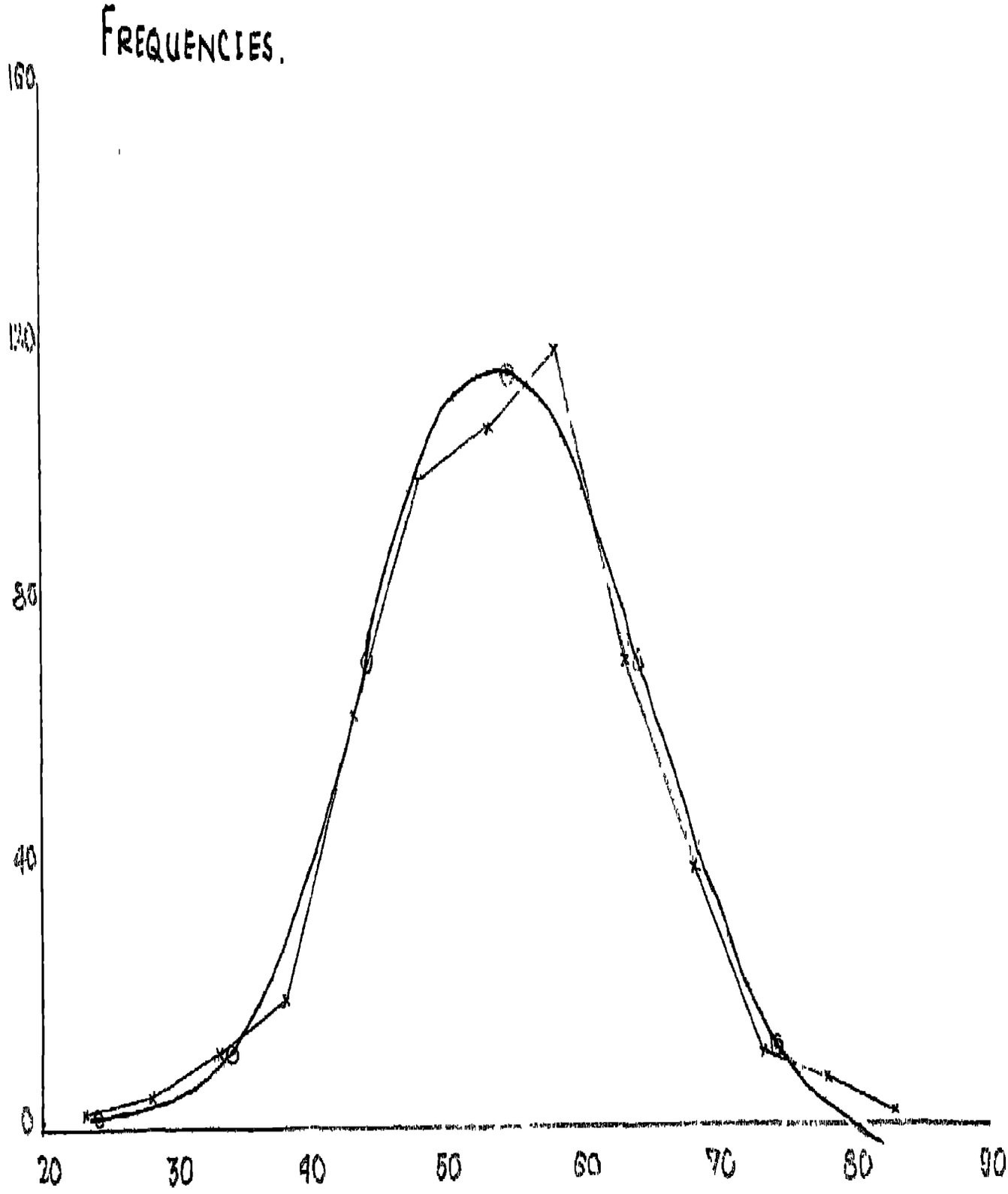
FREQUENCY CURVE FOR STD 4. [Table no. IV]

The frequency curve for standard 4 has a mean of 35.9 and a median of 37.5, Q of the curve is 6,8 and the standard deviation is 10. The skewness of the curve is = 3.04 and the standard error .5 . The skewness is very significant. This may be due to the fact that the examination of the 4th standard is taken by the department and the strictness in promotion leads to a large number of failures. This explains the negative skewness as the repeaters in Standard 4 have done better in the test. The skewness is .26 and the deviation of .003 is negligible.



FREQUENCY CURVE FOR STD. 5. [Table no IV]

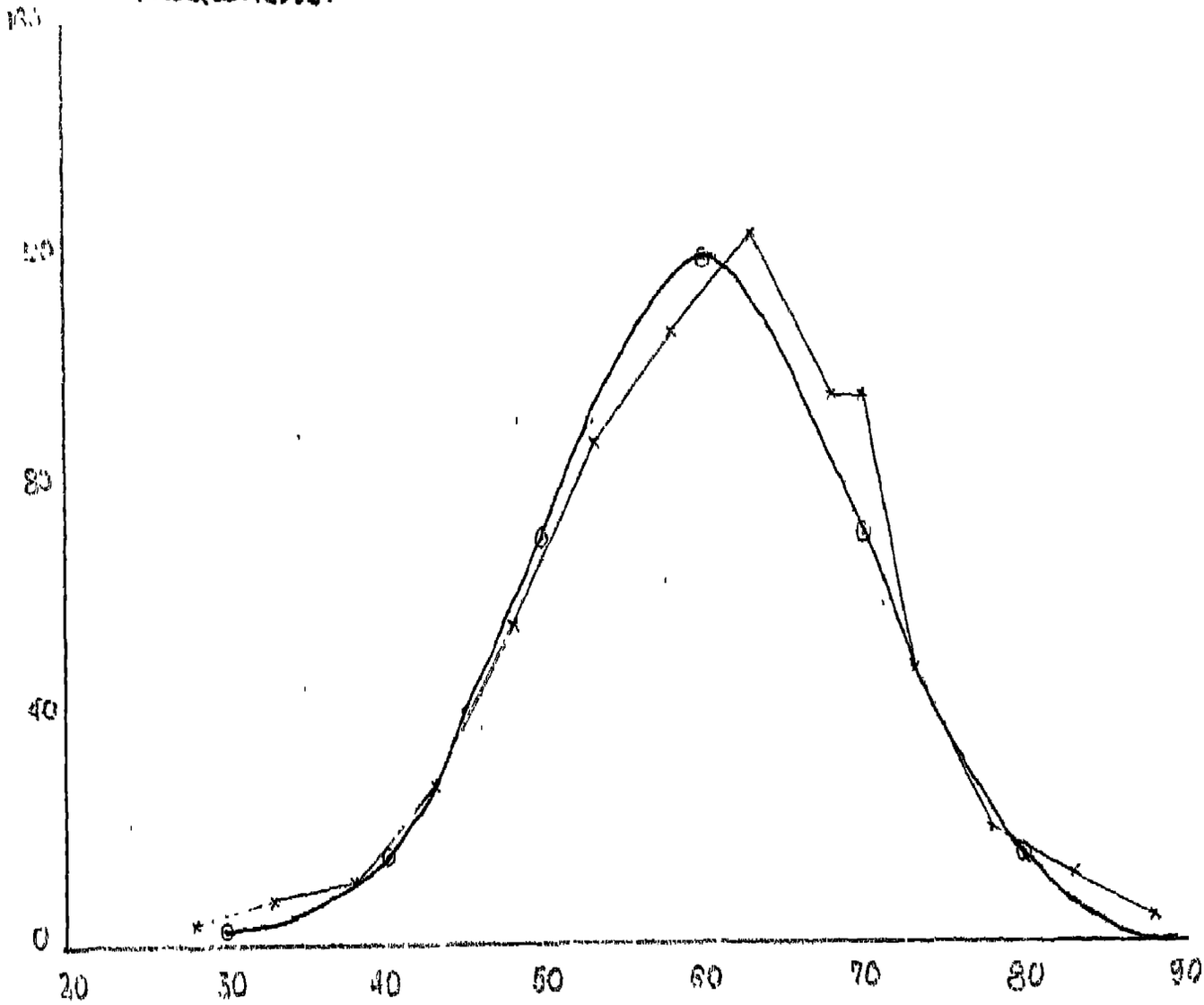
The curve for standard 5 has a mean of 46.9, a median of 47.2, Q = 6 and a standard deviation of 9.1. The skewness of the curve is -.2 with a standard error .5. The kurtosis is .254 with standard error of the order of .01. The deviation from the kurtosis of the normal curve is .009 and it is leptokurtic. This is shown by the slightly high peak of the actual curve. Both skewness and kurtosis are negligible and the curve can be considered to be normal.



Frequency Curve For Std. 6. [Table no. IV]

The curve for standard 6 has a mean = 53.7, a median = 53.9 and standard deviation = 9.7. The semi-interquartile range is 6.9. The skewness of the curve is -.2 and its standard error is .56. The kurtosis of the curve is .26 with the standard error = .01. This curve is very slightly leptokurtic and negatively skewed. The skewness is quite insignificant and the curve tends to be normal.

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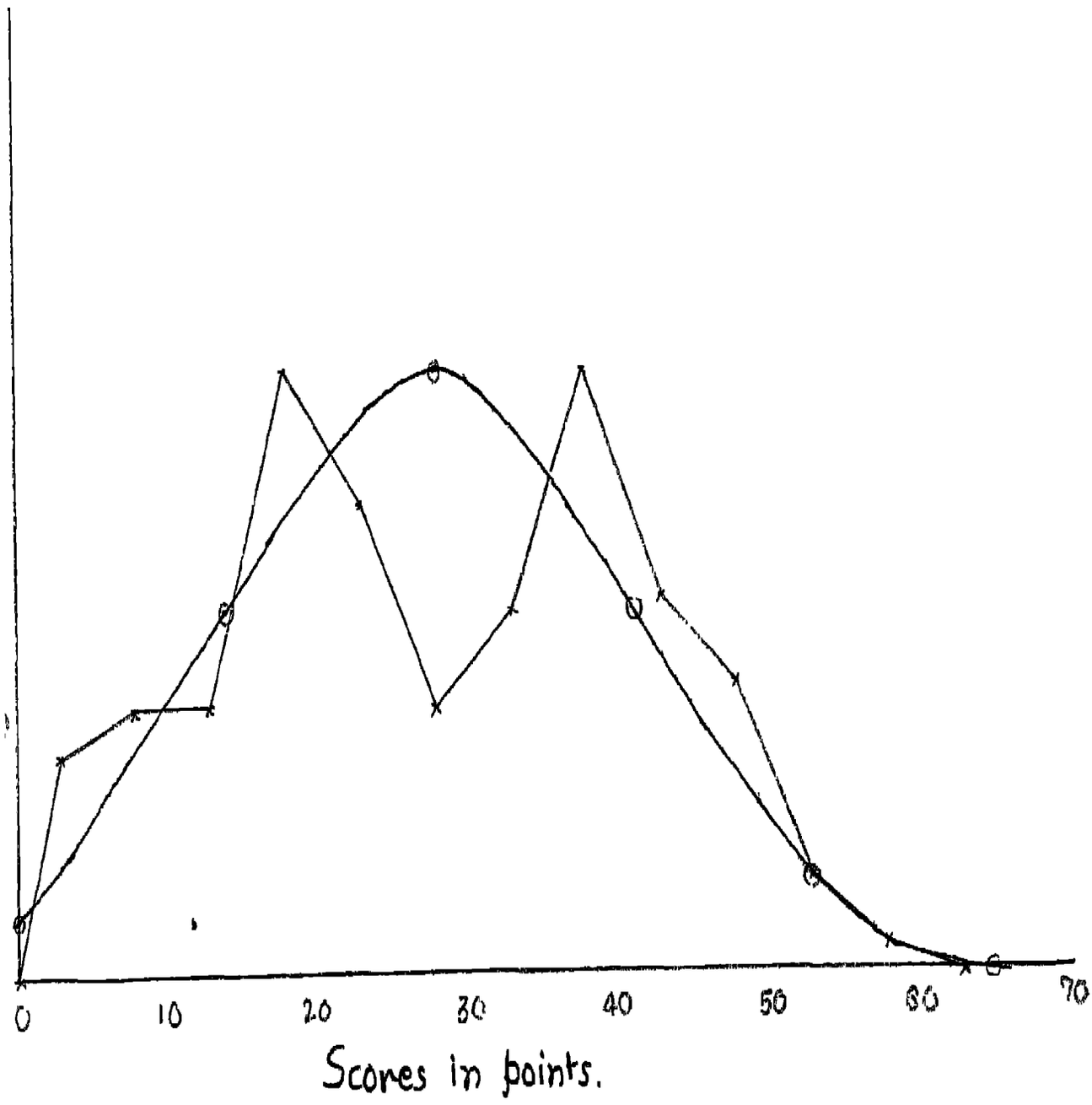


Frequency Curve For Std. 7 [Table no IV]

The frequency curve for standard 7 has a mean of 60 a standard deviation of 10 and $q = .69$. Its skewness is -.9 with a standard error = .6. It is slightly negatively skewed and the skewness is not significant. Its kurtosis is .27 and the deviation from that of the normal curve is very slight. The standard error of kurtosis is .015. This curve is very nearly normal.

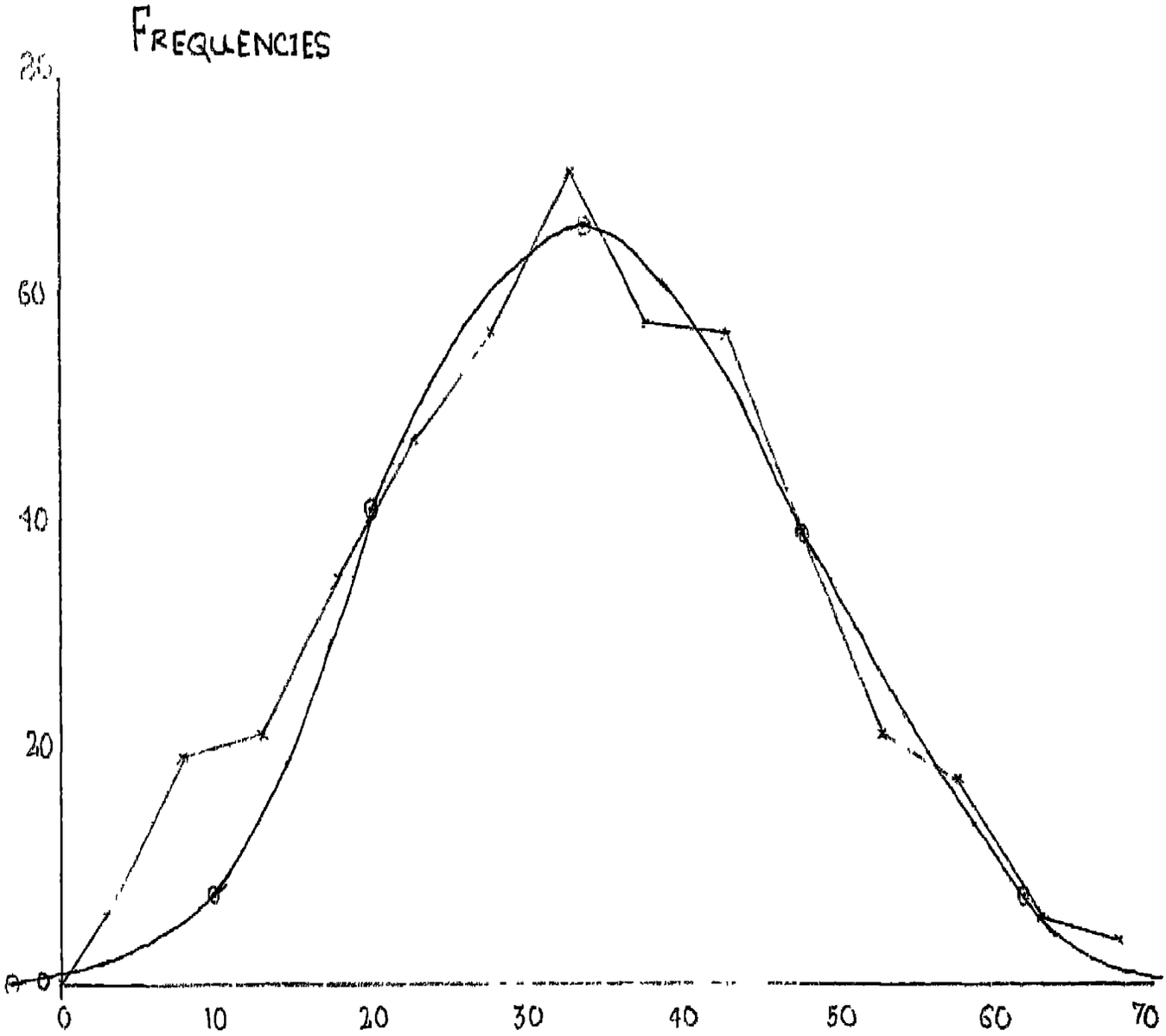
Summarising the results of the study of the frequency distributions of the scores of the standards it is seen that the curves for standards five to seven follow the normal curve closely. The curve of the 4th standard is significantly skewed with a slight deviation from the normal. The skewness was explained by the effect of the departmental examination in standard four - a procedure resulting in a large amount of detention due to failures. The curve for standard three definitely deviated from the normal. This was due to the lack of control of the processes of reading and writing required in answering a written test.

The curves for the various age groups have been described below in detail.



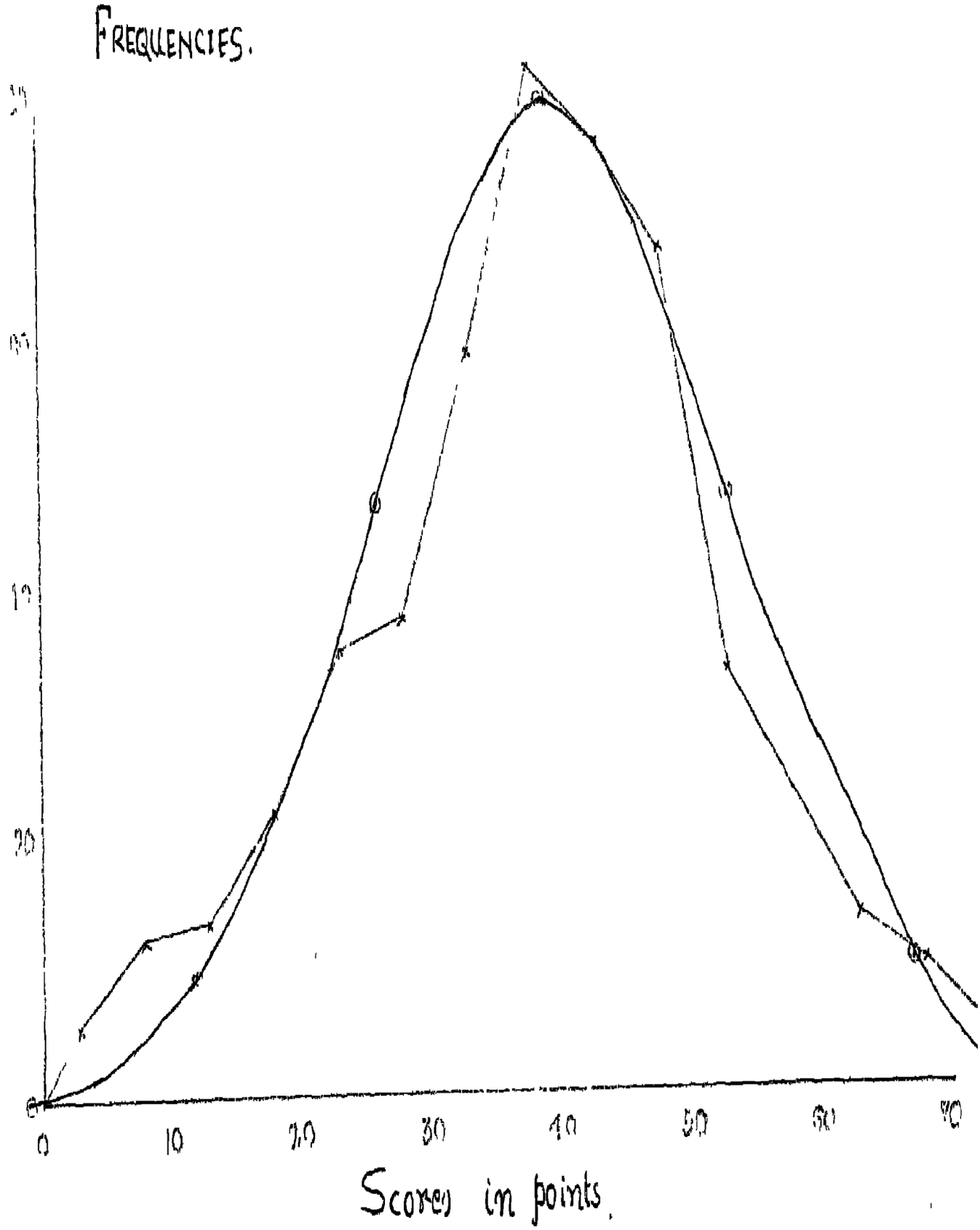
FREQUENCY CURVE FOR THE SCORES OF AGE GROUP 9+ [Table no. V]

The curve for the age group of 9 years has a mean of 28.4 and a standard deviation 14.5. Q of the curve is 10%. Though this curve has a slightly bimodal appearence its skewness and kurtosis are .3 and .28 respectively. Both these figures are not significant and the deviation from normal is not serious.



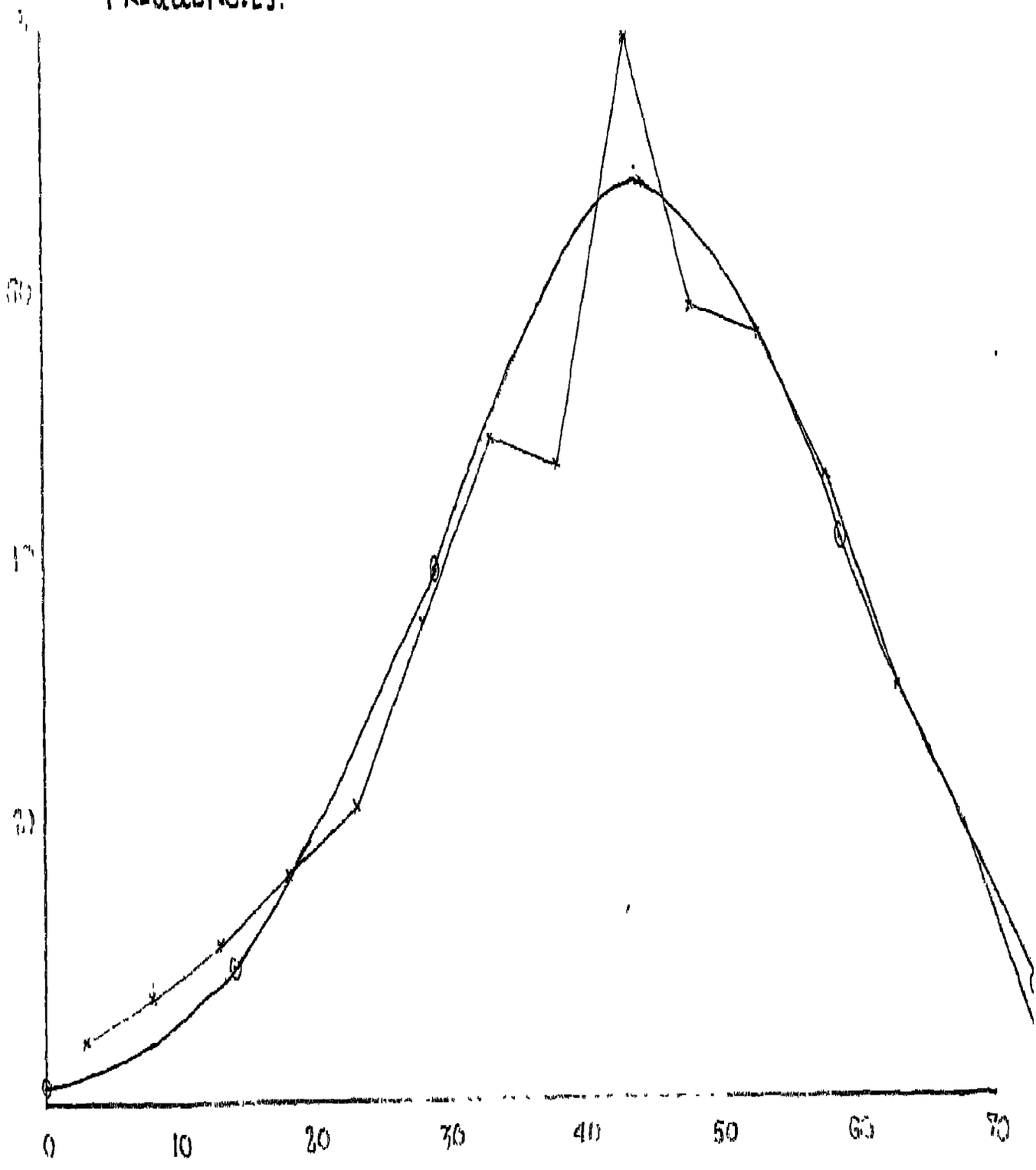
Frequency Curve For The Age Group 10+ [Table no. V]

The curve for the scores of 10 years has a mean 34.7, a median 33.5 and a standard deviation 13.7, Q is equal to 10. The curve has a very small positive skewness of .8 and standard error .9. The kurtosis of the curve is .27 with a standard error .02.. Kurtosis is insignificant and the distribution tends to normality.



Frequency Curve For The Age Group Of 11+ [Table no V]

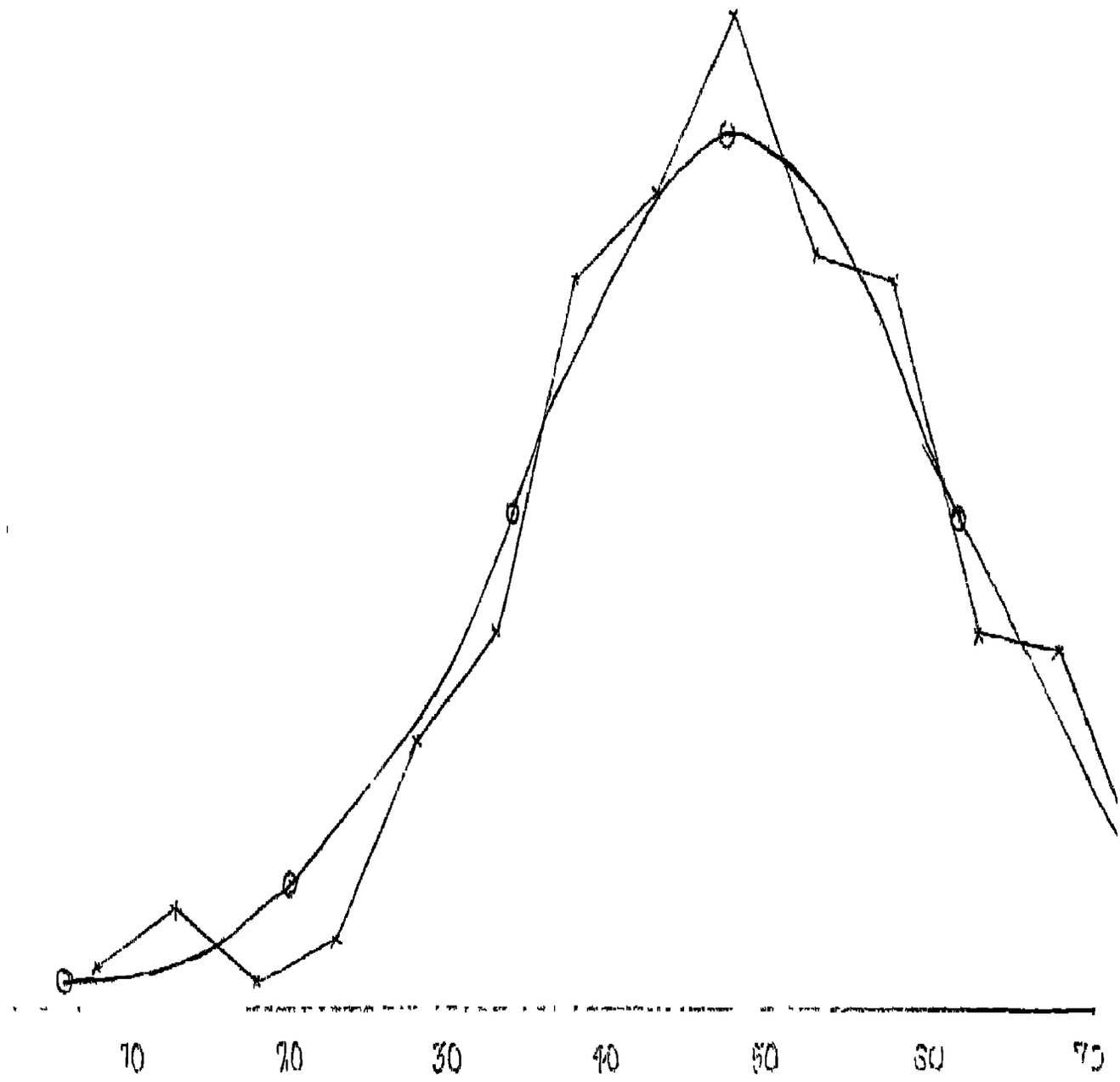
The curve of the agegroup 11 + has a mean 38.6, median 39, σ 14.5 and Q of 9. The skewness of this curve is significant as it is - 1.7 and the standard error of .5. The kurtosis is .26 and does not differ significantly from that of the normal curve.



Frequency Curve For The Age Group 12+ [Table no V.]

This curve has a mean 43.5, median 43.6 and a standard deviation of 15.1. Q of the curve is 10. The slight negative skewness of - .9 is not significant. The kurtosis is .253 and is negligible. The curve can be supposed to be normal.

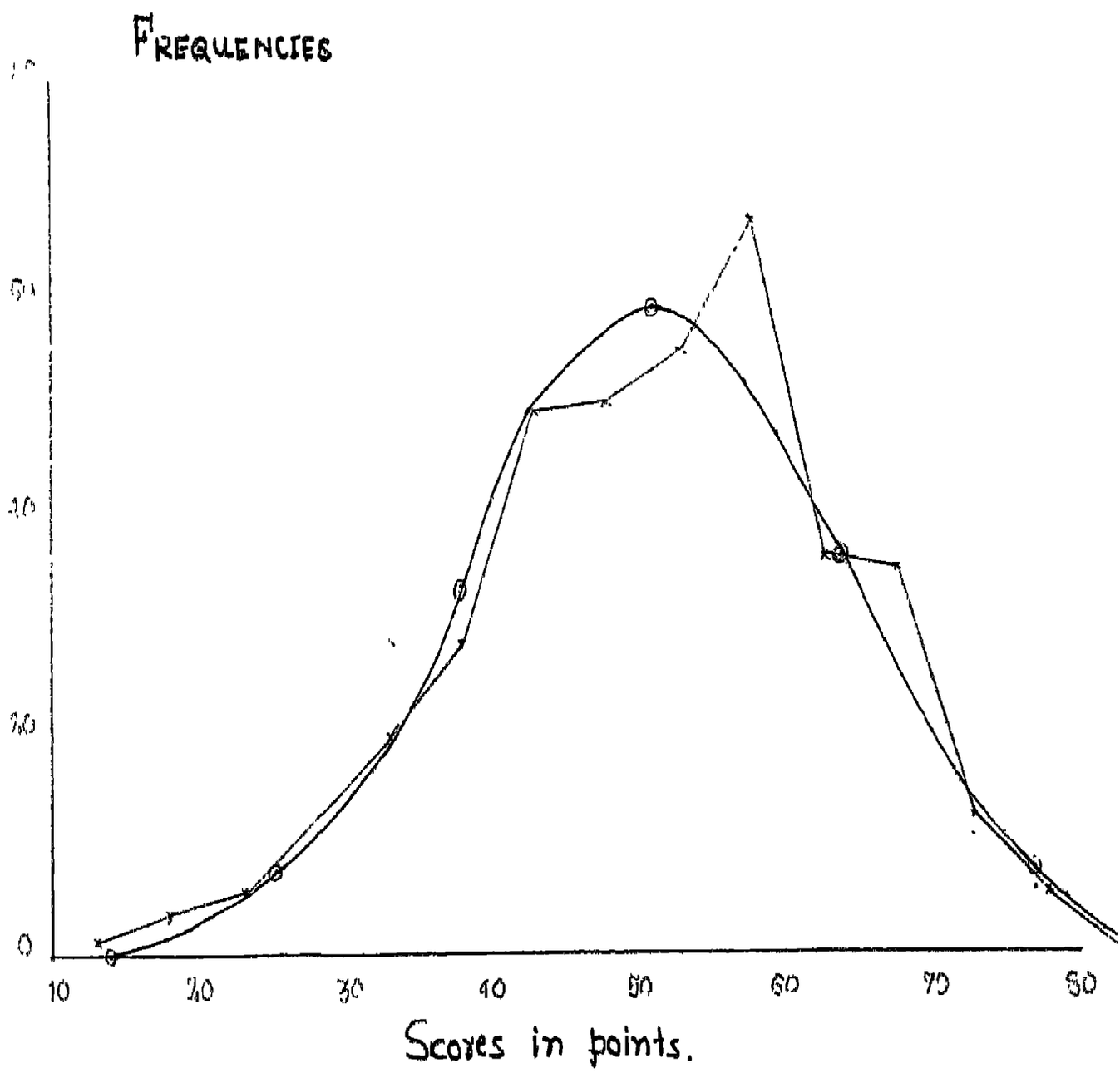
Frequencies.



Score in points.

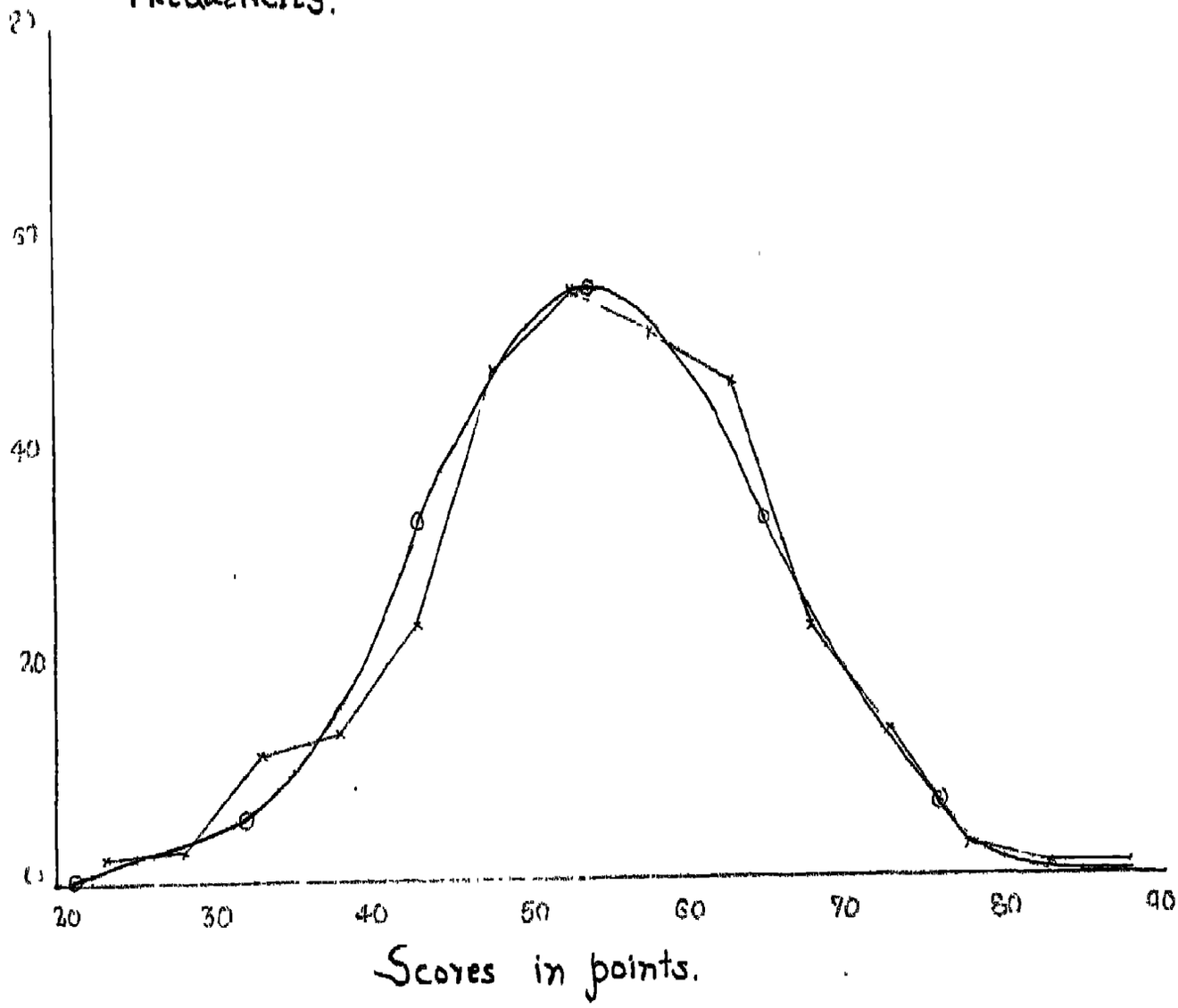
Frequency Curve For The Age Group 13+ [Table no. V]

The mean and the median of the curve for age 13 are 48 and 48.1 respectively. Q for the curve is 9 and the standard deviation is 14.2. The skewness and kurtosis are respectively - .2 and .26. They are negligible and the curve is normal.



Frequency Curve For Scores Of The Age Group 14+ [Table no V.]

The frequency curve for the group of 14 years has a mean 51.5 and a median 52.7. The skewness of this curve is negative. Q is 8.9 and the standard deviation is 13.4. The kurtosis is 27. Skewness and kurtosis are both insignificant and the deviation from normality is slight.



Frequency Curve For The Age Group 15+ [Table no. V.]

The curve for the age-group of 15 years has mean and median 54.3. Q is 7.8 and the standard deviation is 11.1. Skewness is nil and the kurtosis is .26. The curve is nearly normal.

Looking to the results of the twelve curves it is found that only two viz., for Standard 3 and standard 4 deviate from normality. All the remaining 10 curves approximate to normal distribution to a large extent.

Dr. Garret enumerates 4 reasons for the lack of normality. They are: (1) Unrepresentative or biased sampling; (2) Use of unsuitable and poorly made tests; (3) Measurement of traits the distributions of which are not normal and (4) The influence upon distribution form of errors made in the construction and administration of the tests.

The study of the curves shown above shows that the test is free from any of the defects. The asymmetry of the table of standard 3 is due to the fact that the pupils were not accustomed to the use of ~~bad~~ lead pencil. In the case of the 4th standard the skewness is due to the fact that the department examined the children of the 4th standard and hence the effect of the failed students in the 4th standard was shown in the curve.

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CHAPTER VI.

MAKING NORMS TO THE TEST.

When the achievement test has been administered to the pupils and scored, the result is a raw score for each pupil. A raw score by itself is quite meaningless. If a student obtains a raw score of 90 in a test it does not give any definite information regarding the pupil. It may mean different things under different circumstances. 90 out of a maximum of 100 may mean a very good score while 90 out of an aggregate of 500 may mean a very poor score. On the other hand it may mean the second score in a group of 50 children which means a good score or it may be the 25th out of a class of 50 students when the score will be considered quite average. Same can be said about any raw score on any achievement test. This state of affairs makes it imperative to have some basis of comparison for the interpretation of a single raw score.

Absolute units of measurement do not exist for mental measurements and achievement tests as they exist for physical measurement. A performance in high jump or in long jump can be compared with an absolute standard of a certain height or length for example 4 feet in high jump and 15 feet in long jump. In the absence of such an absolute standard in the achievement

of

of arithmetic it becomes necessary to relate the performance of pupils one to another. Thus the arithmetical or mental ability of a student cannot be interpreted meaningfully as successful or unsuccessful with respect to an absolute standard. The degree to which this ability is commendable can only be known by relating it to the arithmetical or any other ability of other pupils. This is so because it is impossible to set up an external yardstick for such measurements regardless of the status of a pupil in comparison with another pupil. The impossibility of defining the level of performance on any given test without relating the scores to those of other pupils results in the necessity of techniques for making the indicated comparisons between pupils. These levels of per-
-formance on a test attained by defined groups of pupils are called norms.

The following are the important norms used for inter-
-preting the performance of pupils on a standardized achieve-
-ment test.

(1) Grade norms.
(2) Age norms.
(3) Percentile scores.
(4) Standard scores.
(5) T scores.
(6) Letter marks.

The first two viz. the grade norms and the age norms will be dealt with in this Chapter while the remaining four will be considered in the next.

Norms

Norms which enable the interpretation of a students' raw score as equivalent to that achieved by typical pupils at a given grade level are called grade norms. These are derived by giving the test to representative groups of pupils at various grade levels and calculating the measures of central tendency (the mean and the median) for the pupils in each grade. The average score of the group in a given grade can then be used in the interpreting subsequent raw scores as equivalent to the test performance of that level.

The following factors must be carefully scrutinised before deriving the grade norms.

In the first place the selection of the pupils must be a random selection. In the present test the pupils were selected in a random manner from 37 schools in five Talukas of the Kolhapur District.

Secondly a large number of schools in widely scattered areas must be used. The number of pupils examined in each grade was decided to be about 500.

Thirdly the policies of promotion or failure of all the schools must be similar. This condition is fully satisfied in this test as all the schools have been selected from one District and hence from the same administrative unit.

Lastly the subject must be given equal importance in all grades for which the nroms are to be established. As this subject is compulsory for the S.S.C.examination its importance for the various grades does not fluctuate.

The

The grade norms provide a reasonable basis for the practical interpretation of scores as well as of individual accompalishments. Usually these norms are computed on the performance of the pupils at the end of the grade. This, however, is not absolutely necessary. The norms in the present test are computed on the achievement at the beginning of the year as it is more necessary for the teacher to know the abilities of his pupils in the beginning of the year so as to plan his instruction on a sound basis. If the norms in terms of the achievement at the end of the year are required, the beginning of the year norm may very well be considered as the end of the year norm for the previous standard as practically no improvement in learning takes place during the holidays. It is quite necessary to state the period of testing and finding the norms.

Grade norms provide a convenient means of expressing the progress of the pupils through the grades by turning his raw score into the grade equivalent score. In the present test the beginning of the year norms for the third standard is 21 and that for the fourth standard is 36. Thus the end of the 2nd standard and the 3rd standard norms are 21 and 36 res--pectively. The next table shows the grade norms for the present test. They are slightly adjusted so that the difference of scores between any two grades may have a simple fractional relation with 12.

Table

Table No. VI.

Table showing the grade norms.

Standard (Beginning of year).	No. of cases.	Mean.	P.E. of mean.	Median.	Standard Deviation.	Final norm.
3	740	22.4	0.27	21.2	11	21
4	865	35.9	0.23	37.5	9.9	36
5	662	46.9	0.24	47.2	9.1	46
6	560	53.7	0.28	53.9	9.7	54
7	600	59.8	0.27	60.4	10.4	60

The next table showing the grade equivalents for raw scores has been constructed on the basis that 21, 36, 46, 54 and 60 are the scores at the end of the 2nd, 3rd, 4th, 5th and 6th grade respectively.

Table No.VII.

Table showing Grade Equivalents for raw scores.

Score.	Grade equivalent.	Grad Score.	Grade equivalent.	Score.	Grade equivalent.
21	2.0	36	3.0	51	4.6
22	2.1	37	3.1	52	4.8
23	2.2	38	3.2	53	4.9
24	2.2	39	3.3	54	5.0
25	2.3	40	3.4	55	5.2
26	2.3	41	3.5	56	5.3
27	2.4	42	3.6	57	5.5
28	2.5	43	3.7	58	5.7
29	2.5	44	3.8	59	5.9
30	2.6	45	3.9	60	6.0
31	2.7	46	4.0		
32	2.7	47	4.1		
33	2.8	48	4.3		
34	2.9	49	4.4		
35	2.9	50	4.5		

This table is very useful to compare the performance of the pupils in a grade. Age

Age Norms.

The second important derived score is the age norm. In deriving age norms the raw scores of the pupils are grouped according to their chronological age groups regardless of their position in the grades. The means and medians of these frequency groups are calculated as usual.

In calculating the age norms only the pupils from 9 years to 15 years were taken into consideration as the number of pupils in the chronological age-groups below 9 years and above 15 years was found not to be large enough to warrant the computation of the norms.

The following table shows the statistical constants of the distributions of the scores according to the age-groups. The final norms have been slightly adjusted for ease of calculation.

Table No. VIII.

Table showing Age Norms.

Age Group.	Number of cases.	Mean.	Probable error of mean.	Median.	Standard deviation.	Final norm.
9 Yrs.6 M.	328	28.4	.55	28.0	14.5	27
10 " " "	475	33.7	.42	33.5	13.7	33
11 " " "	506	38.6	.41	39.0	14.5	39
12 " " "	511	43.5	.40	43.6	15.1	44
13 " " "	415	48.0	.47	48.1	14.2	48
14 " " "	386	51.5	.48	52.5	13.4	51
15 " " "	303	54.3	.42	54.3	11.1	54

In the above table the age-group of 9 years ranges from 9 years to 9 years and 11 months. The average age for the norms

is

is taken as 9 years and 6 months i.e., 114 months. Similarly the ages for the remaining groups will be considered to be 126 months 138 months and so on. The following table shows the age norms when the corresponding ages are changed into months.

Table No. IX.

Ages.	114	126	138	150	162	174	186
Norms.	27	33	39	44	48	51	54

The difference between the scores for the ages of 114 and 126 months is 6 units. Hence an increase in age of two months corresponds to an increase of one unit in the score. Similarly the arithmetical ages for the raw scores can be cal-culated. The next table shows the arithmetical age corres-ponding to the various raw scores.

Table No. X

Table showing the arithmetic age for the given test scores

Score.	Arithmetic age.	Score.	Arithmetic age.	Score.	Arithmetic age.
27	114	38	136	49	166
28	116	39	138	50	170
29	118	40	140.4	51	174
30	120	41	142.8	52	178
31	122	42	145.2	53	182
32	124	43	147.6	54	186
33	126	44	150	55	190
34	128	45	153	56	194
35	130	46	156	57	198
36	132	47	159		
37	134	48	162		

The

The data of this table will enable us to compare the performance of pupils of various ages with the age norms and find whether the pupils are doing good average or poor work.

In order to compare the performance of the pupils with each other, use can be made of the idea of the Arithmetic Quotient similar to the Intelligence Quotient used in mental testing. The Arithmetic Quotient is calculated by multiplying the ratio between the Arithmetic Age and the Chronological Age by 100. The formula for A. Q. is :

$$\text{A. Q.} = \frac{\text{Arithmetic Age}}{\text{Chronological Age}} \times 100.$$

An A. Q. of 100 is considered as normal, of less than 100 as inferior and of greater than 100 as superior. By calcu-lating the A.Q's of the pupils, those deviating considerably from the normal can be treated separately. A remidial course can be given to the inferior and retarded group and a special treatment can be given to the superior group.

Age norms are affected by more uncontrollable factors than the chronological age of the pupils as compared with the grade norms. Overageness, retardation and a serious lack of balance between retardation and acceleration are the chief factors affecting the achievement of children. The chronological age of a pupil in the sixth standard may be 13 years 6 months at the end of the school year but the mean test score of the pupils of 13 years 6 months is not the same as the end of the year score for the sixth standard.

Again

Again the actual achievement of the underage pupils is significantly superior to that of overage pupils in a given standard. Hence the calculations of norms for standardised tests should carefully take into consideration the wide differences in maturity, the mental ability and the school progress in a given standard.

Many reputable standardized tests are accompanied by age norms without regard to the level of the standard and hence the interpretation of individual pupil achievement on the basis of these norms is likely to be misleading.

CHAPTER VII.

OTHER SCALES OF MEASUREMENT.

Grade norms and age norms are described in the previous Chapter. The four scales of measurement viz.,(1) Percentile Ranks, (2) Z Scores, (3) T Scores, and (4) The Letter Grades are described in this Chapter.

Usually the method of ranking is used to compare the performance of one pupil with that of another. The useful--ness of this method is limited as it does not take into account the actual level at which the accomplishment takes place. A boy's rank may be 45th out of a group of 50 or it may be 45th out of a group of 500 students. The second performance can be called superior while the first may be called very inferior. Percentile ranks are used to avoid this confusion by reducing the ranking to a basis of 100. For example a percentile rank of 40 means that for the measure under consideration the pupil assigned that rank made a score which exceeds the score of 40% of the pupils regardless of the number of cases it contains.

The percentile ranks for the scores of standards 3 to 7 and the scores of ages 9 to 15 are given in the two tables which follow.

Table

Table No. XI.

Table showing the percentile scores of the standards 3 to 7

Percentile Rank.	Standards.				
	3	4	5	6	7
10	7.1	21.5	35.3	41.6	46.5
20	11.7	28.0	40.2	45.8	51.3
30	15.8	32.0	42.8	48.6	54.7
40	18.9	35.0	45.2	51.3	57.6
50	22.2	37.5	47.2	53.9	60.4
60	25.4	39.7	49.3	56.4	62.8
70	29.5	41.9	51.5	58.8	65.3
80	33.0	44.1	54.3	61.7	68.3
90	37.1	47.2	58.5	65.8	72.5

Table No. XII.

Table showing the percentile scores for the age groups of 9 years to 15 years.

Percentile Rank.	Ages.						
	9	10	11	12	13	14	15
10	10.6	14.9	19.1	23.4	30.5	35.6	40.5
20	15.6	21.3	26.4	30.7	37.2	41.5	46.0
30	19.6	26.2	32.0	35.8	41.3	45.4	49.0
40	23.7	31.0	36.1	40.9	45.1	48.4	52.1
50	29.0	34.3	39.8	44.1	48.1	52.8	55.2
60	34.5	37.2	42.3	47.8	51.4	56.3	58.5
70	39.6	41.2	45.7	52.0	55.4	59.7	60.5
80	41.6	45.4	49.5	56.5	59.5	61.7	63.5
90	46.2	51.8	55.5	62.0	66.1	68.2	70.0

Percentile ranks have a disadvantage that the difference between the scores of two percentiles differing by the same space are not equal. Thus the difference between the 40th and 30th percentile is not the same as that between the 90th and the 80th percentile.

This difficulty is removed by using two more derived scores (1) The Z score or the standard score and (2) the T score. Both these scores depend upon the arithmetic mean and the standard deviation of the distribution. The 'Z' score has been defined by the following equation.

$$Z = \frac{X - M}{\sigma}$$

where X = the raw score

M = Arithmetic mean,

σ = Standard deviation.

For example the 'Z' score for the raw score of 30 in a distri-bution whose arithmetic mean is 60 and standard deviation is 10 will be - 3. Similarly the 'Z' score for a raw score of 80 in the same distribution will be + 2. If the raw scores are 23 and 77 the 'Z' scores will be - 3.7 and 1.7 respectively. Thus the 'Z' score can have a negative, positive integral or a decimal value.

In order to remove this difficulty McCall devised a score named T score. It is named 'T' score in order to commem-orate the names of Thorndike and Terman. This score is very similar to the Z score. It eliminates the negative quantities by representing the arithmetic mean of the distribution as

a T score of 50 and equating the standard deviation of the distribution to 10 T score units. The formula for a T score is

$$T = \frac{10\,(X - M)}{\sigma} + 50$$

where X, M and have the same connotation as that in the 'Z' score. In fact the Z score can be transformed into the T score by the formula

$$T = 10Z + 50.$$

The third important type of the derived score is the letter mark. The letter mark is constructed by the use of the arithmetic mean and the standard deviation. The letters A, B, C, D and E are used. Their meanings should be known to every teacher.

A - Excellent
B - Superior
C - Average
D - Inferior
E - Poor

A scores are those ranking more than 1.5 standard deviations above the mean.

B scores are those ranking between .5 and 1.5 standard deviation above the mean.

C scores are those ranking between .5 standard deviation below and .5 standard deviation above the mean.

D scores are those ranking between .5 and 1.5 standard deviation below the mean and

E score are all those below 1.5 standard deviations from the mean.

CHAPTER VIII.

CRITERIA OF A GOOD TEST.

Every examination must satisfy certain conditions if it is to be useful . The following are the important characteristics of a good test.

(1) Validity,

(2) Reliability.

(3) Objectivity.

(4) Administrability.

(5) Interpretability.

The validity of a test is the degree to which it measures what it proposes to measure. It is necessary to make the objectives quite clear. In the first place a test must be valid from the point of view of the curriculum. For this purpose, the test constructor must consider the course of study, objectives of the instruction of the subject, the analysis of text books, analysis of questions at the final examina-tions and the psychological analysis of the mental processes involved in the subject.

This may be defined as curricular validity and the present test possesses the same to a very good degree as the objectives are stated very clearly as the application of the four fundamental processes to whole numbers, denominate numbers, fractions and decimals together with an application of the same

for

for the solution of simple problems in everyday life. All other factors are attended to.

The second kind of validity depends upon the test scores and may be called the statistical validity as compared with the curricular validity which depends upon the test content. In order to determine the statistical validity the scores of a group of pupils are correlated with the scores according to a certain criterion like the examination marks or the scores on some other standardized test. In the case of this test the correlation coefficient between the teachers' marks and the scores on the test ranged from .72 to .87. As the marks given by teachers are affected by factors like attendance, work habits, personal likes and dislikes and other subjective matters, the above correlations may be said to be quite high.

In the second place statistical validity can be judged from the increase of scores per standard as well as per year of chronological ages. The average scores from the third to the seventh standard are 21, 36, 46, 54 and 60 respectively. Thus in standards 3 and 4 the rise is more rapid and in the higher grade standards 5, 6 and 7 it is less rapid.

Thirdly the validity can be assessed from the performance of two groups widely separated in ability. This is done by comparing the scores of rural pupils with those of the urban. The following table gives these scores.

Table XIII

Table showing Average scores of rural and urban children.

Type of pupils.	Standards				
	3	4	5	6	7
Rural	21	36	46	54	60
Urban	26	42	51	60	65

The differences

The differences in the averages are found to be statistically significant. This is shown in detail on the Chapter on rural and urban comparisons.

Finally validity can be found by the method of correla-tion of the scores in this list with those in other similar lists. This could not be done for want of a similar test for rural children.

Reliability of the Test.

The reliability of a test is the accuracy with which it measures what it proposes to measure. What a test measures may not be what it proposes to measures but if it measures accurately it is a reliable test. Thus if a test is valid it must be reliable. On the other hand a reliable test may not be valid.

The following methods are used to find the reliability of the present test.

I. The test re-test method: The test was given to the same children after about a month and a half. The correlation coefficient between the two sets of scores was .92 thereby showing high reliability of the test. This method has a dis-advantage. It involves the memory factor and tends to increase the correlation coefficient. In order to avoid the effect of memory the test may be given after a sufficiently long period. In this case the factor of extra learning will affect the results.

II. Split test method: This method of finding the reliability of a test avoids the disadvantages of the above

method

method because the coefficient of correlation between the scores on the odd and even items of the same test is found out. The factors of memory and extra learning are not involved in this method. This gives the reliability of one half of the test with the remaining half. The Spearman-Brown formula is used to change this reliability into the reliability of the whole test. The formula is:

$$\text{Reliability of the whole test} = \frac{2(\text{Reliability of half test})}{1+(\text{Reliability of half test})}$$

In this test the coefficient of correlation for the half test was .84 and that for the whole test calculated from the above formula was .92.

III. Method of Kuder and Richardson: Kuder and Richardson have provided a very simple method for the estimation of the reliability coefficient of a test. It does not involve splitting the test into two halves, rescoring twice and calculating the coefficient of correlation. The only data required in this method are the number of items in the test, the arithmetical mean of the total score on the test and the standard deviation. The formula is :

$$r = \frac{n}{n-1} \cdot \frac{\sigma^2 - npq}{\sigma^2}$$

where n = number of items in the test

$$p = \frac{\text{Arithmetic mean}}{n}$$

$$q = 1 - p$$

For example if $n = 100$; A. M. $= 60$ and $\sigma = 11$ as in the case of the 7th standard, we will get $p = .6$ and $q = .4$.

Hence $r = \frac{100}{99} \times \frac{121 - 100 \times .4 \times .6}{121} = \frac{100 \times 97}{99 \times 121} = .82.$

The following table gives the reliability coefficients by standards.

Table No. XIV.

Table showing Reliability according to standards by the method of Kuder and Richardson.

Standard	Number of Items.	Arithmetic Mean.	Standard Deviation.	Reliability.
3	100	22	11	.86
4	100	36	10	.78
5	100	46	9	.73
6	100	54	10	.76
7	100	60	11	.82

This formula underestimates the reliability of a test to the extent of the variation in difficulty among the items and a reliability above .6 is considered to be quite high.

The third important characteristic of a test is its objectivity. In fact it was the subjective nature of the traditional examination that led to the development and rapid spread of the standardised achievement tests. A test is objective when the personal judgment of the scorer does not affect the scores. In this test each question has one and only one specific answer and the chance of any subjective judgment influencing the score is very small. A rescoring of a sample of 80 papers shows but an occasional lapse in the clerical part of the scoring. Otherwise the correlation between the two scorings is perfect.

In the

In the fourth place a test must be easy to administer. Administrability is the characteristic of a test that is concerned with ease, clarity and uniformity in its administra--tion and preparation for its administration. Definite instructions are given in the test and it was found that the test is very easy to administer.

Lastly the test should be easy to interpret. The utility of a test depends upon the provision of criteria for the inter--pretation of the scores made by the pupils. The grade and age norms the percentile ranks and the arithmetic ages of the pupils give almost a complete interpretation to the arithmetic achievement of the pupils. The Chapter on the Analysis of Errors helps to study the pupils' ability in arithmetic.

CHAPTER IX.

AN ANALYSIS OF ERRORS IN ARITHMETIC.

The results of an achievement test provide information about the general standing of a standard or a pupil as compared with the norm of the test. The score itself only reveals the situation but is of no further use. If the results of a test are to be of any use, the study of the results must be taken a step further. If the test is given only for the sake of knowing the score of a child, it will be not of much use and the time and money spent on it will be as good as wasted.

In order to achieve real profit from the testing the answer books must be carefully studied for the sake of errors. Arithmetic is a subject, very notorious for the errors committed by pupils in every process. The process of learning the basic elements of arithmetic is so complex that the number and types of mistakes made by the pupils are quite large.

The errors in each process will be studied separately. The errors in addition of whole numbers can be divided into the following groups.

(1) Errors of combination.

$$\begin{array}{r} 5 \\ +\ 3 \\ \hline 7 \end{array} \qquad \begin{array}{r} 18 \\ +\ 16 \\ \hline 35 \end{array}$$

These are two examples of the error of combinations.

In the

In the former example the student says, five and three are seven instead of eight and in the latter case he says eight and 6 are fifteen and writes five. The frequency of errors of this type is quite remarkable. The percentage of this kind of error in the 3rd standard is 41.6%; in the 4th standard it is 39.8; in the fifth standard it is 16.3; in the sixth standard it is 13.5 and in the seventh standard it is 6.4. (Vide appendix No.IV). page 138

The probable reason for this type of error is the lack of mastery possessed by the students. The basic combina--tions of addition are not taught septematically by the help of concrete materials and the imperfect understanding of the pupils leads the students either to use the method of counting on fingers or worse that of guessing.

The only remedy for this is to teach the combinations so that the children will understand them. Hurry in teaching the basic facts of addition must be avoided and the children must master these facts sufficiently well before they are taught any higher processes in arithmetic. A good deal of concrete material must be used in order to clarify the concepts of numbers and a meaningful study of groups up to 10 must be made.

(2) Errors of carrying.

The errors of carrying are mainly of the following three kinds.

(a) <u>Not carrying the carried number:</u>

Example: (1) 4309
7183
5964
16346

(ii) 6
48
462
93
3
592

In example

In example (i) the student has omitted to add the carried number in each of the 2nd, 3rd and the fourth column from the right. In the second example (ii) the student did not add the carried figure of 2 from the first column to the second. He however carried the one from the second column to the third.

(b) Carrying wrong number:

Example:

```
   6
  48
 462
  93
   3
-----
 602
```

From the first column the student carried one instead of two. He carried correctly from the second to the third column.

(c) Writing the carried figure:

Example:

```
  36
  24
-----
 510
```

The student has written the carried figure of one instead of adding it to the second column.

The most probable cause of these errors is the lack of attention on the part of the pupils. The teacher must find the cause of this type of error and correct it as early as possible.

(3) Errors

(3) Errors in the addition of denominate numbers.

These errors are chiefly of two kinds:

(a) Carrying as in the addition of whole number.

Example:

Yds.	Ft.	In.
4	1	9
3	2	7
7	4	6

In this example the student has written 6 from 16 and carried 1. He has not carried the yard from feet as the sum is less than 10.

(b) Omission of carrying.

Example:

Hours	Minutes	Seconds.
4	15	30
2	50	40
6	65	70

The seconds, minutes and hours are added like whole numbers and carrying is completely lost sight of.

The most probable reason of the above type of mistakes is the lack of understanding on the part of the pupil. He has not understood the tables of denominate numbers because they have been taught without any meaning to the child. The other important reason is that these tables have been taught to the child for a very short period and their application has not been made systematically. This is also due to the fact that the tables have been introduced at an early stage and the child has not reached a level of growth required for the understanding of the tables.

The remedy

The remedy for this is to teach the process of the addi-tion of denominate numbers more thoroughly and systematically. The process should be taught for a longer period and repeated revisions should be taken to see that the child has mastered the process.

(4) Errors in the addition of fractions.

(a) Adding numerators and denomination.

Example: (i) $\frac{2}{7} + \frac{3}{7} = \frac{5}{14}$

(ii) $7\frac{1}{3} + 6\frac{1}{4} = 13\frac{2}{7}$

In the first example the numerators and denominators have been added separately. In the second example the integers have been added correctly whereas the addition of the frac-tional part is not right.

(b) Not bringing the answer to the mixed fraction.

Example:

$$7\frac{1}{3} + 6\frac{1}{4}$$

$$= \frac{22}{3} + \frac{25}{4}$$

$$= \frac{88 + 75}{12}$$

$$= \frac{163}{12}$$

The whole working is correct but the answer is kept as an improper fraction even after a clear instruction in the test.

The reason for the error in the addition of fractions is the insufficient and unsystematic teaching of fractions in the primary schools. The students do not understand the real

meaning

meaning of fractions and therefore neglect them.

The remedy for this is better teaching. The explanation of the terms numerator and denominator must be given in such a way that the children can understand their meaning. The illustrative examples must be graded very properly and the errors of the pupils must be corrected at the beginning of the course in fractions.

(5) Errors in decimal fractions.

(a) Ignorance of placing the decimal point:

Example:

7.25	3.92
8.14	+ 7.54
1.539	+ 2.78
	1424

In the first example the decimal point is placed wrongly while in the second example the decimal point is omitted.

(b) Ignorance of carrying from the decimal part to the integral part:

Example:

3.92
+ 7.54
+ 2.78
12.224

The decimal and the integral parts are added separately and the figure to be carried from the fraction to the integer is written in the answer. The percentage of errors in decimals goes on increasing from the fifth to the seventh standard. It is 19.2 in the fifth standard, 20.9 in the sixth and 27.2 in the seventh.

The errors

The errors in decimal fractions are due to a lack of understanding of the decimal nature of the number system. The errors can be easily remedied by giving the children a clear idea of the positional value of a digit in a number and how it goes on increasing tenfold to the left and goes on decreasing by one-tenth to the right.

Errors in subtraction.

(1) Subtraction of whole numbers.

Errors in subtraction can be grouped in the follow-ing four heads: (a) Errors in combinations, (b) Errors of Borrowing, (c) Errors due to inverted subtraction, and (d) Errors due to ignorance of the process.

(a) Errors in combinations:

(i) 11 − 5 = 7 (ii) 6 − 2 = 3

The two errors exemplify the error of combination. These errors occur right from the beginning in the third standard and persist till the end in the 7th standard. Their percentages are : In the third standard 38.8; in the fourth standard 29.2; in the fifth standard 13.6; in the sixth standard 7.3 and in the seventh standard 7.5.

As in addition the chief reason for the errors of combi-nation in subtraction was the lack of mastery.The students were using the method of counting on fingers showing thereby that they had not mastered the basic combinations of subtraction.

The remedy

The remedy for this error lies definitely in better teaching of the process. The combinations must be taught by the help of concrete materials and students must be prevented from using their fingers for counting. In some schools the children used the following method for subtraction. In subtrac-tion 28 from 47, he made 47 dashes and then cancelled 28 and counted the remaining dashes. This is definitely due to bad teaching of the process of subtraction.

(b) Errors of borrowing.

(1) Borrowing when not necessary.

Example: (i) 23 (ii) 937

-10 -482

---- ----

3 445

In both examples the students have borrowed from tens which was not necessary.

(2) Not borrowing when necessary:

Examples: (i) 40 (ii) 137

- 16 - 28

---- ----

34 119

The students have not borrowed from the second column.

(3) Double borrowing.

Example: 140

- 17

113

In this example the student borrowed two instead of one from the second column.

Most

Most probably, the errors of borrowing are caused due to a lack of the understanding of the idea of ten, the basic idea of the number system. This idea is very probably taken up when the students are not ready forit. It is then left for ever, thinking that the students have mastered the idea. When the time for the application of that comes the students commit errors.

As in the case of addition, the remedy for this error lies in a very systematic teaching of the idea of ten. This teaching should be revised again and again until the pupils achieve a reasonable mastery of the process. The review of the idea of ten should be made at the beginning of every year till the fifth standard and the teacher should make sure by the use of tests that the idea has been understood and that the students use the idea of ten with reasonable accuracy.

(c) Miscellaneous errors.

(a) Inverted subtraction.

Example:

$$\begin{array}{r} 137 \\ -\ 28 \\ \hline 111 \end{array}$$

Obviously the student has subtracted 7 from 8 in the first column. The rest of the solution is correct.

This error is due to the ignorance of borrowing. As the student cannot subtract the larger number from the smaller he simply inverts the process. A proper understanding of the process of borrowing will minimise this kind of error.

(b) Errors

(b) Errors due to ignorance.

Example:

$$\begin{array}{r} 11 \\ -\ 5 \\ \hline 16 \end{array}$$

In this sum the student has added instead of subtracting. This error is either due to carelessness or due to the inability of the student to diffeentiate between the various processes.

(2) Errors in the subtraction of denominate numbers.

(a) Subtracting as in the case of whole numbers.

Example:

Yds.	Ft.	In.
7	- 1	- 8
- 2	- 2	- 10
4	- 8	- 8

In this example the student has treated the foot as a column of 10 and the yard as a column of 100.

(b) Omission of borrowing.

Example:

Hours.	Min.	Sec.
3	- 19	- 40
- 1	- 40	- 50
1	- 39	- 50

In subtracting 50 seconds from the 40 seconds the student has borrowed but he has omitted the borrowed number while doing the subtraction of minutes. These two errors comprise 15 p.c. in the 4th standard, 20 p.c. in the 5th standard, 21 p.c. in the 6th standard and 28 p.c. in the

seventh.

seventh. The percentage goes on increasing inspite of the improvement in the performance on these items (No. 12, 13, 14, see Table No. XVI, Chapter X) because the number of students attempting these items goes on increasing.

(3) Errors in fractions.

(a) Subtracting numerators and denominators.

Example $\frac{8}{9} - \frac{2}{3} = \frac{6}{6}$

In this example the student obviously has not under-stood the difference between the numerator and the denominator of a fraction.

(b) Not giving the answer in the mixed form.

Example: $5\frac{1}{8} - 2\frac{3}{4} = \frac{41}{8} - \frac{11}{4}$

$= \frac{41 - 22}{8}$

$= \frac{19}{8}$

This is left as an improper fraction in spite of the specific instruction in the test.

(4) Errors in decimal fractions.

(a) Ignorance of placing the decimal point in the answer.

Example: (i) $.86 - .46 = 40$ (ii) $8.48 - .59 = .789$

In the first example the decimal point is not placed at all, while in the second example the decimal point is placed wrongly.

It is

It is very difficult to give a definite reason for the errors in the subtraction of denominate numbers, common fractions and decimal fractions. The only probable reason is the insufficient mastery of the fundamental processes of addition and subtraction of whole numbers. If correct methods of carrying and borrowing are made clear and meaningful at the outset then the errors in denominate numbers fractions and decimals will be automatically minimised. The correct teaching of the difference between the numerator and the denominator will go a long way in reducing the error in fraction. A thorough understanding of the idea of 10 will minimise the errors in the subtraction of decimals.

Errors in Multiplication.

In the multiplication of whole numbers students commit a large number of mistakes in the combinations of tables. For example, 13 x 6 = 58 and 16 x 8 = 104. The percentage of errors in the various standards is as follows:

3rd Standard - 42.5%; 4th standard 36.4%; 5th standard 23%; 6th standard - 8% and 7th standard - 6.3%

The reason for these errors is evidently the lack of mastery of the tables. The multiplication combinations are taught in the schools by the method of rote and as the students do not understand anything they sometimes commit wrong combinations by heart. So much time is spent on the revision of the tables that practically very little else is taught in the first two standards. The wrong habits formed at this stage

are

are carried over in the higher standards and the children commit mistakes in the multiplication of whole numbers. All these errors can be eliminated if the idea of multiplication is taught at the beginning by the study of groups. The meaning of the tables up to 9 should be made clear by the use of concrete objects and then the tables should be memorised .

The second important mistake in the multiplication of whole numbers is that of the arrangement of partial products. For example:

$$\begin{array}{r} 550 \\ \times\ 37 \\ \hline 3850 \\ 1650 \\ \hline 5500 \end{array}$$

The student does not know the reason for the shifting of the second partial product one place to the left. This is due to the fact that he does not realise the meaning of posi-tion of a number. These errors will be eliminated if the idea of the positional value of a number is stressed till the children show an adequate mastery.

The errors in denominated numbers are chiefly of two types. In the first type the student multiplies as in whole numbers. For example:

Yds.	Ft.	In.	
3	2	8	328
	x	8	x 8
26	2	4	2624

The student

The student has worked the example as if it is an example in whole numbers.

The second type of error is illustrated by the following example.

Hrs.	Min.	Sec.
2	50	40
	x	9
18	450	360

The first type of error is due to the ignorance of the process of multiplication of denominate numbers while the second type is due to a wrong understanding of the tables. Adequate teaching will definitely improve this type of error.

In the multiplication of fraction the errors are due to the omission of cancelling and not changing the answer to the mixed form. The first is illustrated by $\frac{3}{16} \times \frac{4}{9} = \frac{12}{144}$

The answer is not changed to 1/12 by cancelling. The second is illustrated by $4 \times 2\frac{7}{8} = \frac{4}{1} \times \frac{23}{8_2}$

$= 23$

The answer is left as an improper fraction and not corrected to $11\frac{1}{2}$ even though the mix instruction in the test is specific about this point.

Two types of mistakes occur in decimals. (1) The mistake of not placing the decimal point at all and (2) placing the decimal point in the wrong place.

4	.043
x .5	25
20	.1075

The two examples illustrate the two types of mistakes.

The errors

The errors in the multiplication of fractions and decimals are caused because the processes are not taught properly. It may also be due to a lack of the understanding of the number system because of an inadequate understanding at the beginning of the course.

Errors in Division.

The errors in the division of whole numbers are partly due to the ignorance of the multiplication tables and partly due to the ignorance of finding the true quotient figure in the process of long division. 6) 42 (6 is an example of the error due to tables. 17) 359 (1

17

---

189 is an error because the quotient figure is wrong.

A third type of error creeps into division because of the presence of zero either in the dividend or in the quotient.

4) 432 (18

4

32

32

00

The answer is found to be 18 instead of 108.

All these errors cannot be traced to a particular reason as in the case of addition and subtraction of whole numbers. Division is a complex process and requires a thorough knowledge of the fundamentals on which it is based. As the children are taught most of these basic facts before they are ready to understand them, the errors can be avoided by teaching the difficult process at a later stage.

All the

All the errors committed by children cannot be found from their written work alone. An error like 5 - 3 = 7 can be identified as one of combination which the child does not know. In an example like 17 - 9 = 71 the error cannot be detected. The processes of thinking performed by the child are not clear. In such an example the error can only be detect-ed if the thinking is done aloud. Thus when the child says that 7 - 9 are 16 and 6 and 1 are 7 the error is detected as the child carries 6 from 16 instead of 1. This type of error of carrying cannot be detected in the written test.

It is also necessary to obtain information as to the nature of the errors made in the various number processes by children at various stages of growth and the kinds of diffi-culties they encounter.

The analysis of errors in the fundamental processes of arithmetic reveal the following facts.

Firstly it reveals that there is much trial and error learning in the beginning stage of arithmetic and guessing is very common.

Secondly this type of learning is very common when the basic ideas of the number system have not been carefully developed.

Thirdly poor and unsystematic teaching in the initial stages of the learning of arithmetic is a major factor contributing to the error.

Lastly well planned presentation and development of a process

process will eliminate much of the trial and error type of learning.

The following quotation from Breuckner will make the point more clear.

"Judd, Brownell and Others have demonstrated by experiment that the child's grasp of the number system grows slowly and also that children in the lower grades have widely different controls over the concept of precision. Number is not a mode of thought with which the child is innately endowed. Power to use number results from the continued use of number in a wide variety of situations in which pupil can see number functioning in the affairs of daily life. The degree of control of the pupil over basic number concepts may be inferred from the methods he uses in manipulating number facts. Inadequate methods of work tend to disappear as maturity increases. It is apparent however that unless careful provision is made for the efficient control of number ideas in the lower standards the pupil may be handicapped in the upper grades. The deeper and broader the pupil's number experiences are in the lower grades the more efficient is their grasp of the number system and its functions. To limit these experiences to the computational function alone as is so x often done in the primary grades, results in a much more meagre background of meanings than will result if due consideration is given to the development of concepts relating to the informational, sociological and psychological functions of the subject.

To achieve

To achieve a good understanding of the number system a clearcut programme of remedial instruction must follow the analysis of errors. The chief purpose of all testing is the accurate determination of class and individual difficulties to the effect that remedial instruction may follow. Of even greater importance is the new angle which exactly analytical and diagnostic testing gives to the preventive phases of instruc-tion through the anticipation of causes of weakness and difficulties" .(5)

(5) Yearbook of the N.S.S.E. 1938.

CHAPTER X

A STUDY OF THE SYLLABUS IN ARITHMETIC.

In general the objectives of arithmetic instruction can be divided into two distinct categories. The first category consists of the computational objectives comprising the sixteen possible combinations of the four kinds of operations viz. addition, subtraction, multiplication and division and the four kinds of numbers viz., whole numbers, common fractions, decimals and denominate numbers. The second category consists of problem solving which may be divided into five distinct abilities.

(1) Ability to comprehend

(2) Ability to determine what is given

(3) Ability to determine what is required.

(4) Ability to think of the probable answer

and (5) Ability to find the correct answer.

For a long time it was thought that the teaching materials in a subject should be selected on the basis of formal discipline. As it has been proved experimentally that learning is a very specific activity and very little if at all is carried over from one type of learning to another type, it is now generally agreed that the selection of materials should be made for their social value rather than for their disciplinary value.

The processes of computation are made up of a large number of basic skills and abilities. Unless these are thrown

thoroughly

thoroughly mastered the more difficult problems cannot be properly learnt. Again it is commonly recognised that even the learning of the basic skills demands a minimum mental develop--ment. If the skills are taught before the pupils are ready to understand them, they are not mastered. As a result a distaste for arithmetic is caused. Many authorities are agreed upon what the materials of instruction in the arithmetic course should be. A considerable difference of opinion exists upon the distribution of the materials over the various standards.

The old courses of study in arithmetic were really difficult for the mental calibre of the pupils for whom they were intended. The old syllabus was overloaded with computa--tional processes of a very abstract nature. The tables were given an undue importance and naturally the method of rote learning was used by the teachers. The syllabus revised in 1955 has relieved this situation to a certain extent. The summary of the syllabus is given in the adjoining table. The course is divided into nine topics.

(1) Counting,
(2) Addition
(3) Subtraction
(4) Multiplication,
(5) Division
(6) Money
(7) Weights and Measures,
(8) Fractions and decimals,
(9) Problems.

The syllabus

The syllabus of Arithmetic revised in 1955 is described below according to standards.

Standard 1. Age (6 +)

Counting - Counting and reading numbers 1-100 with the help of concrete objects. Explaining the idea of 10. To study the table of 2's, 3's, 4's, 5's and 10's by groups. Writing 1-100 and tables 2,3,4,5 and 10.

Addition - Adding any number upto 9, to any number upto 20, with the use of concrete objects.

Subtraction - Subtracting any number upto 9, from any number less than 20, with the use of concrete objects.

Standard 2. Age (7 +)

Counting - Counting, understanding and reading through 1000. Tablesupto 12 and of 16. Writing upto 1000 and tables 1 to 12 and of 16.

Addition - Addition of two place numbers to two place numbers. Idea of carrying.

Subtraction - Subtracting two digit number, from another two digit number. Idea of borrowing.

Multiplication - Multiplying a two digit number by one digit number.

Division - Dividing a two digit number by a single digit number.

Money - Introduction to current coins.

Problems - Simple one step problems on tables.

Standard 3. Age (8 +)

Counting - Reading and writing of number through 10000. Tables upto 20.

Addition

Addition - Addition of numbers through 4 places.

Subtraction - Subtracting a 4 digit number from a 4 digit number.

Multiplication - Multiplication in which product do not exceed 4 digits.

Division - Dividend of not more than 4 digits. Divisor less than 20.

Money - Subtraction of money.

Weights and Measures - Use of a clock. Introduction of the units of time, distances, and weights. Addition and subtraction of weights and distances.

Fractions - Idea of $\frac{1}{2}$, $\frac{1}{3}$, and $\frac{1}{4}$.

Problems - One step problems on daily activities, including money, distances and weights and other problems learnt so far.

Standard 4. (age 9 +)

Counting - Reading and writing through one crore. 'Reghi' system.

Addition - Revision.

Subtraction - Revision.

Multiplication - Revision.

Division - Revision. Divisor shouldnot exceed two digits.

Money - Revision of addition and subtraction, multiplication and division of money; multiplier anddivisor not exceeding 20.

Weights and measures.- Revision of addition and subtraction.

Multiplication

Multiplication and division of weights, time and distances not to exceed 20.

Fractions - Revision of $\frac{1}{2}$, $\frac{1}{4}$ and $\frac{3}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{12}$

Problems - Unitary method. Direct problems not containing fractions.

Standard 5. (Age 10 +)

Addition - Revision.

Subtraction -Revision.

Multiplication -Revision.

Division - Revision.

Money - Revision.

Weights and Measures - Revision. Area of rectangle, walls, floors of a room. Idea of Acre.

Fractions - Reduction. Comparison of fractions. Kinds of fractions. Addition, subtraction, multiplication and division of fractions, with simple problems.

Problems - Three kinds of problems. Problems in fractions. Average. Proportion.

Standard 6 (Age 11 +)

Money - Exchange of Rupees, pound and dollar.

Fractions - Complex fractions. Four rules applied to decimals. Changing fractions into decimals.

Problems - Percentage, commission, discount, interest, profit and loss.

Standard 7 (age 12 +)

Weights and Measures - Area of a triangle and circle. Idea of II. Surface

Surface are of a cylinder. Volume of a cylinder.

Problems - Simple interest, Compound interest, Proportion. Time-work and speed.

The study of the standardwise division of the syllabus will be found to be lacking in system in two ways. In the first place the gradation of the course is quite arbitrary and not scientific. The course for the first standard for example is too heavy if it is to be taught properly. Counting, formation of the concepts of numbers from 1 to 9 by the use of concrete and semi concrete materials, the study of groups by comparison, the use of zero and the idea of ten are basic to a proper understanding of the processes in arithmetic. These ideas must be taught and must not be left to chance as is likely to happen in the present syllabus. This demands a very careful gradation of the course as is shown in the proposed syllabus (see page 104)

In the second place the teaching becomes hurried and unsystematic because the fundamental processes are taught in two or at the most in three standards. For example the processes of addition and subtraction are completed by the end of the 3rd standard and the difficult processes of multiplication and division are taught in two standards only viz. the 3rd and the 4th. All these processes are quite complex for the immature mind of the child who cannot understand them if they are not taught in a very simple and meaningful way. The topic in area

in area is begun in the 5th standard and again taken up in the 7th.

The present test is made up of 5 subtests. The study of the scores on the subtests made by the different standards brings out certain interesting facts. The following table gives the scores.

Table No. XV.

Table showing average scores for the addition, subtraction multiplication, division and problems separately.

Standard.	Addition.	Subtraction.	Multiplication.	Division.	Problem.	Total
3	7.5	5.0	5.3	3.7	2.0	23.5
4	10.0	7.6	8.6	6.0	4.9	38.1
5	11.5	10.1	9.2	7.5	8.4	45.7
6	12.4	12.0	10.7	9.5	10.3	54.9
7	13.4	13.2	12.6	10.7	11.0	60.9

In order to study whether the division of the course by standards is adequate or not it is necessary to know the achievement of the pupils on each item on each subtest. It is usual to consider the achievement of 50 per cent as adequate and any inferior achievement may be considered as inadequate. Table No. (XVI) shows the results for addition. This subtest of addition consists of 9 examples on whole numbers and 3 examples each of denominate numbers, common fractions and decimals.

Table No. XVI.

Table showing the percentages of children solving the addition sums correctly.

Item number	Standards.				
	3	4	5	6	7
1	90	95	98	95	100
2	88	95	98	98	100
3	91	92	98	100	100
4	85	90	94	98	100
5	70	85	95	95	98
6	90	90	95	95	100
7	60	80	92	90	98
8	60	75	94	98	98
9	30	72	84	90	90
10	30	55	70	84	95
11	22	42	60	80	90
22		18	50	50	55
13		5	30	42	50
14		5	35	46	60
15			18	28	25
16			10	18	30
17			5	15	20
18				32	45
19				18	30
20				22	30

decimals. A careful analysis of the table shows that children of the third standard cannot add three columns of three digit numbers (sum No.10) satisfactorily. They find the sum of 3 numbers of four digits as well as a sum of broken columns to be very difficult. The difficulties shouldbe cleared in the 3rd and the 4th standards and the study of addition should be continued in the upper standards for speed and accuracy.

The revised syllabus requires the addition of denomi-nate numbers in the third standard. The table shows that the achievement of denominate numbers at the beginning of the fourth standard is only 18 p.c., 5 p.c., and 5 p.c. respectively for the three simple sums. The addition of denominate numbers should therefore be taken in the fourth standard instead of in the third. Even in the fifth and the sixth standard the achieve-ment is not adequate. This is due to the fact that the process is taught before the children are fit to learn it and the sufficient mastery is carried on in the higher standards.

The results on fractions (items 15, 16 and 17) are very poor for the three upper standards. This shows a k lack in the understanding of the ideas of fractions. In order to overcome this it is necessary to understand the ideas in a meaningful way.

The results of the addition of decimals (item Nos. 18, 19, 21) also are quite low. It is interesting to see, however, that they are better than the results on fractions. These results can definitely be improved if the idea of 10

and the

and the decimal nature of the number system is made more clear to the children.

The following conclusions can be drawn from the results on the subtest in subtraction (See Table No.XVII on next page).

The children at the beginning of the third standard cannot subtract a two digit number from another two digit number adequately if the sum involves borrowing (item 5, 6). The results on more difficult sums viz., subtracting a two digit number from a three digit number (item 7, 8) and those involving three and four digits are not mastered by the children. These sums, however, are solved adequately in the 4th and higher standards.

The subtraction of denominate numbers (item 12,13 and 14) is adequate at the beginning of the sixth standard. In the fourth and the fifth standard the children do not show a suffi-cient understanding of this process.

The children show a proper understanding of fractions (items 15, 16 and 17) at the beginning of the 7th standard. In the beginning of the & 5th and even in the 6th standard their results are very poor.

The results for decimals are better than those for fractions. 30 p.c., 15 p.c., and 2 p.c. children solve the sums in fractions correctly while 40 pc., 30 p.c. and 10 p.c. children solve the sums on decimals at the beginning of the 6th standard.

The following

Table No. XVII.

Table showing the percentages of success in subtraction.

Item No.	Standards.				
	3	4	5	6	7
1	70	80	100	98	100
2	70	90	100	98	100
3	55	82	95	97	92
4	55	85	97	96	95
5	45	72	94	95	100
6	30	62	94	92	95
7	25	70	98	92	98
8	25	52	91	95	95
9	19	50	88	90	95
10	10	48	75	80	90
11	6	45	70	92	90
12		12	30	46	70
13		2	25	52	60
14		2	20	40	48
15			15	30	60
16			5	5	20
17			2	0	12.5
88				40	60
19				36	55
20				10	30

The following conclusions can be made from the results on multiplication. (See Table No. XVIII below).

Table No. XVIII.

Table showing the percentages of success in Multiplication.

Item No.	Standards				
	3	4	5	6	7
1	85	95	95	100	100
2	80	92	95	98	100
3	85	95	95	98	97
4	80	95	95	98	97
5	75	92	95	100	100
6	70	92	95	95	100
7	75	82	95	92	97
8	50	74	89	90	95
9	55	80	80	80	92
10	15	36	55	72	80
11	8	12	25	50	60
12		17	30	35	42
13		14	29	40	40
14		8	12	35	30
15				37	60
16				15	18
17				6	15
18			2	14	40
19				4	20
20				2	20

The achievement

The achievement on the first nine items is very satisfactory. These items are based on the knowledge of tables upto 20. The results have fallen down very much as soon as multiplication proper ~~that is~~ begins. Items No. 10 and 11 (550 x 37 and 4087 x 57 respectively) have not been satisfac--torily solved even at the beginning of the 4th and 5th standards.

The multiplication of denominate numbers, of fractions as well as of decimals shows a great lack of understanding. In the item No. 15, only the 7th standard has shown a success of 60 p.c. In many cases the success is below 20 p.c.

The following conclusions can be drawn from the results in Division (See Table No.XIX on next page).

Children at the beginning of the 3rd standard can divide by single digits and find difficulty when the divisor exceeds 14. In the beginning of the 4th standard, children do not show a proper understanding, when the example involves zero (Items No. 8, 9). For example 4) 432 and 400) 295600. Understanding of the process of division of whole numbers is adequate by the time the children have reached the 6th standard.

The results show a complete lack of understanding of the process of division as applied to denominate numbers, fractions and decimals. In no case the success is above30 p.c. In many cases the success has not reached even the mark of 10 p.c.

Table No.

Table No. XIX.

Table showing the percentages of success in Division.

Item No.	Standards.				
	3	4	5	6	7
1	60	97	100	98	100
2	60	97	100	100	97
3	55	90	95	97	97
4	60	90	92	100	97
5	50	92	92	94	97
6	25	60	85	90	92
7	20	38	42	51	70
8	12	34	62	80	90
9	5	18	36	48	60
10	10	22	40	65	80
11	5	9	22	35	65
12		4	6	10	18
13		2	2	4	12
14		2	2	2	15
15				8	15
16				19	22
17				8	18
18				19	30
19				2	18
20				2	15

The results

The results of the above tables show the need for the revision of the grade placement of topics in the syllabus in Arithmetic.

Fortunately the problem of grade placement has received the attention of a large number of first rate research workers in Arithmetic. The most important piece of work on this topic is that of the Committee of seven under the Chairmanship of Dr. C. W. Washburne. This Committee carried over exprimants in 255 cities and towns in 16 states involving 1190 teachers and 30744 pupils. This research was continued for more than 12 years/ beginning in 1926. The general viewpoint emerging from this research is that 'there is a point in a child's mental growth before which it is not effective to teach a given process in Arithmetic and after which that process can be taught reasonably effectively'. Regarding this viewpoint G.M. Wilson remarks "Washburne's study had an immediate effect upon the curriculum and reforms which had been urged for years e.g. deferring systematic drill, even drill on addition, to the 3rd grade, long division to grade 5, fractions to grade 6, were accepted and began to appear as specifications of courses of study. Recent developments in the gradeplacement of topics have been favourable to this view".

The above Committee has provided the makers of a syllabus in Arithmetic the minimum mental age and the optimum mental age for teaching to completi-on each process or a

Large

large section of a process. The following are three illustra-
-tions.

Topic.	Minimum M.A.	Optimum M.A.
Addition facts sums over 10.	7 Yrs. 4 M.	7 Yrs. 11 M.
Like fractions no borrow-ing Addition and subtraction.	9 Yrs. 10 M.	11 Yrs. 1 M.
Long Division all difficulties complete.	12 Yrs. 7 M.	12 Yrs. 7 M.

The significance of such research is apparent. If the abovementioned three topics are diferred to their corres-
-ponding level of growth then the first topic will be taught in the 3rd grade instead of the first, the second will be taught in the sixth and the third will be taught in the seventh. The important fact coming out of this research was the necessity of spreading the teaching of an important process over several years instead of teaching it to completion over a period of two or three years and that too in the first four grades.

Taking into consideration the findings of the results of the present test and the conclusions of the recent research on the placement of topics in arithmetic the following two points come out clearly :- (1) The division of the various topics is not divided on any scientific basis and (2) the

topics

topics are finished in two years and hence cause a hurry in teaching and a consequent lack of understanding in the fundamentals of the number system.

In order to overcome the above two points a syllabus is proposed. The proposed syllabus is given below:

Discription of the proposed Syllabus by Standards.

Standard 1. (Age 6 +)

Counting - 1-100 and from 100 to 1, by 2 to 20, by 5 to 100 by 10 to 100. Build concepts through 6. Study of groups.

Addition - A thorough understanding of groups 1, 2, 3, 4, 5 and 6. Sum not to exceed 6 + sign.

Subtraction - Study of the groups of 1, 2, 3, 4, 5 and 6. Minuend not to exceed 6.

Money - Recognition of pice, anna, rupee.

Weights and Measures - Inch, Foot, Yard , Cup, Dozen.

Problems - Oral solutions of simple problems. Illustrative problems.

Standard 2. (Age 7 +)

Counting - Read and write numbers from 1-100. Count by 2 to 100. Write in words numbers upto 20. Build up concepts of 7-10. Place value of units tens and hundreds. Importance of ten (Informally tables up to 5).

Addition - A thorough grasp of the concepts of 7, 8, 9 and 10

100 basic

100 basic combination. Column addition, sum not to exceed 19. Thorough grasp of 10 and groups of 10. Two digit addends no carrying + sign.

Subtraction - 100 basic combinations. Three (two) digit numbers no barrowing. Study of the groups 7, 8, 9 and 10.

Multiplication - Product not to exceed 10. Thorough developement of the ideas of the groups of 1 to 10.

Division - Dividend not to exceed 10. Part of the study of groups.

Money - Table 4 pice = 1 anna. 16 annas = 1 Rupee. 2 as. 4 as. 8 as. coins and their recognition.

Weights and Measures - Continuation of the previous work and 1 pound.

Fractions - Idea of $\frac{1}{2}$.

Problems - One step problems involving addition and subtraction.

Standard 3. (Age 8 +)

Counting - Read and write numbers 1-10000. Writing upto 1000 in words. Place value through thousands. Read and write Roman numbers from 1 to 10. Tables through 10.

Addition - 100 combinations revised. Column addition of 6 single digits, 2 digits without carrying to three digits numbers with carrying. Horizontal addition of two simple digits. Checking.

Subtraction - 100 combinations continued. Three digits numbers with



with no borrowing to 3 digit numbers with borrowing.
Importance of zero.

Multiplication - 1 digit multiplier and two digit multiplicant
Carrying x sign (Tables of 1-10 by combination).

Division - 1 digit divisor, 2 digit dividend. No borrowing
no remainder. - sign (Tables 1-10).

Money - Addition - subtraction of Rs. and As. Revision
of idea of 2 as. 4 as. 8 as. coins.

Weights and measures - 12 Inch = 1 foot, 3 foot = 1 yard,
16 Oz. = 1 Lb. 2 pt. = 1 qt. 4 qt. = 1 gallon,
Temperature.

Fractions - Idea of $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$.

Problems - Simple problems (1 step) involving 4 rules as learnt.

Standard 4 (Age 9 +)

Counting - Reading and writing through 100000. Number to
words and words to numbers from 1 - 100000.
Place value of ten thousand and hundred thousand.
Roman numerals from 11-20.

Addition - Five addends of 4 digits. Horizontal addition of
two digit numbers. Checking.

Subtraction - Four/ and five digit minuends and subtrahends.
Checking.

Multiplication - Two digit multiplier and two and three digit
multiplicand(Tables 11-20).

Division - One digit divisor. All difficulties. Checking.

Money.

Money - Addition and subtraction of Rs. As. Ps.
Multiplication of Rs. As. only.

Weights and Measures - Mile, gallons, Maund, Time.

Fractions - Concept through $\frac{1}{8}$ $\frac{1}{12}$ and $\frac{1}{16}$ as applied to a singhe object or to a group. Addition and subtrae-tion of like fractions.

Problems - Simple two step problems. Judging answers.

Standard 5. (Age 10 +)

Counting - Reading and writing through 1,000,000.0. Place value of a million. Meaning of ordinals to be clarified till 100th.

Addition - Through five addends with 5 digits. Checking.

Subtraction - Through six digit Minuends and subtrahends.

Multiplication - Three digit multiplier and 4 and 5 digit multiplicands. Zero, difficulties, checking.

Division - Two digit divisor. All difficulties. Checking.

Money - Multiplication and division of money. Division not to exceed 20.

Weights and measures - Weights and Measures addition and subtraction of denominate numbers. Ton - Time continued.

Fraction - Addition and subtraction of mixed numbers with the fractions. Multiplication and division of fractions.

Problems - More complex problems. Problems with hidden answers. Introduction of three kinds of problems in fractions.

Standard 6

Standard 6. (Age 11 +)

Counting - Revision of this work. Place value through 1,000,000,000.

Addition - Revision of the previous work for speed and accuracy Checking.

Subtraction - Revision of the previous work for speed and accuracy. Checking.

Multiplication - Continuating the work for speed and accuracy. Checking.

Division - Three digit divisor. Checking.

Money - Revision of 4 rules for money. Division and multiplication not to exceed 2 digits.

Weights and Measures - Multiplication and division of denominate numbers. Comparison of units. Square measuring. Rule of rectangle.

Fractions - Rivision and difficult examples in fractions.

Problems - More complex problems. Estimating answers. Revision of three kinds of problems, percentage Application simple interest, profit and loss.

Standard 7 (Age 12 +)

Counting - Revision. Number system.

Addition - Revision for speed and accuracy.

Subtraction - Revision for speed and accuracy.

Multiplication - Revision and enlargement of the ideas.

Division - Revision for speed and accuracy.

Money - Revision for speed and accuracy.

Weights and Measures - Revision of weights and measures. Areas of simple figures. Volumes of simple shapes.

Fractions

Fractions - Revision.

Problems - Application of percents, compound interests. Discount, Commission, stock and share profit and loss.

The important changes suggested in the proposed syllabus are discussed below :

(1) The revised syllabus of the state of Bombay requires the addition of any one digit number to any number upto 20 for the first standard. This means the study of formal arithmetic too soon. The children of the first standard do not grasp these ideas. Therefore the proposed syllabus recommends that in the first standard the addition should be such that the sum should not exceed 10 and the study of addition should be made with concrete objects. The idea of ten should be taken up in the second standard. Addition should not include carrying in the second standard. Carrying should be thoroughly taught in the third standards and addends should be three digit numbers. The teaching of addition including the difficult examples should be continued in the fourth and the fifth standards. Addition of money may be introduced in the third standard but should be formally taught in the fourth. The systematic teaching of subtraction should be taken in the second standard. Borrowing should be taken up in the third standard and the teaching of the process should be continued to the fourth and the fifth standard by increasing the digits in the minuend as well as the inclusion of zero in both the

minuend

minuend and subtrahend. Subtraction of denominate numbers should be taught in the fourth standard and should be continued in the fifth.

Secondly multiplication of a two place number by a single digit number is included in the second standard syllabus. Here again much more emphasis is placed on the multiplication tables than on the understanding of the process of multiplica--tion. It is necessary to master the tables upto 10 with as much understanding and meaning as the student is capable of before going further with the process of multiplication. Memorisation of the tables without understanding their meaning is probably the greatest drawback in the teaching of elementary arithmetic. Memorising is inevitable. The understanding is more fundamental than memorisation. Hence the process of multiplication should be systematically tackled in the 3rd standard. The first two years should be used for making the idea of multiplication clear by the help of concrete materials and everyday experiences. The fundamental facts of division should be mastered and then the process should be taught.

Thirdly the writing of numbers starts right from the beginning. This should be defered to the beginning of the second standard or at least to the end of the first standard. The writing of a number in words is very important and should be taught.

Fourthly the process of carrying and borrowing should be taken up in standard three instead of two. The idea that

10's and 100's are added and subtracted exactly like units is of fundamental importance. It also grows very slowly and hence should not be taught hurriedly in the second standard.

Lastly the fundamental processes should be spread over longer periods than they are distributed in the syllabus. The difficult parts of the process of multiplication need to be taught in the 5th and 6th standard. They should be reviewed in every higher standard for spped and accuracy.

CHAPTER XI.

COMPARISON BETWEEN THE ACHIEVEMENT OF ARITHMETIC OF THE RURAL AND URBAN CHILDREN.

The problem of the comparison between the achievement of Arithmetic of rural and urban children is very important. The number of children attending the rural schools is far in excess of the number of children attending urban primary schools, because India is predominantly a rural country. Conditions in a rural school are quite different from the conditions of an urban primary school. In the former one teacher usually teaches two, three or even four classes at a time while in the latter school one teacher usually teaches only one class. In the case of the supply of materials also the rural schools are more neglected than the urban schools. Finally, on the whole, the facilities for learning in a rural environment are inferior to those obtaining in an urban environment. It is therefore necessary to compare the performance of rural children and urban children and to see how far the difference between the two groups is significant.

The next table shows the means of the rural and urban achievements by standards.

Table

Table No. XX.

Table showing the mean of the scores of the rural and the urban children.

Standard.	Mean of Rural.	Mean of Urban.	Difference.
3	22.4	26.9	4.5
4	35.9	42.3	6.4
5	46.4	51.4	5.0
6	53.7	60.2	6.5
7	59.8	65.0	5.2

It is seen from the above table that the mean of the arithmetical achievement of the urban children is higher than that of the rural children in every standard.

Now by comparing the means, it cannot be said that the difference between them is significant.The values of a statistic are computed from a sample. The value is not uniquely determined and fluctuates due to chance factors from one sample to another, from the same population. In order to ascertain whether the difference between the two means is significant or not the standard errors of the two means must be found out. The standard error of the difference of standard errors of the two means by the formula.

$$S.E.\ (diff) = \sqrt{S.E_r^2 - S.E_u^2}$$

Where $S.E._r$ is the standard error of the mean of the rural children and $S.E._u$ is the standard error of the urban children.

The

The critical ratio is then computed by dividing the difference between the two means by the standard error of the difference. If the value of this ratio exceeds 1.96 then the difference between the means is significant at .05 level and if it exceeds 2.58 then the difference is significant at the level of .01.

The calculation of the critical ratio of the difference between the means of the scores of 7th standard is shown below.

	Rural		Urban
N	= 600	N	= 37
M	= 59.8	M	= 65
σ	= 10.4	σ	= 10.5
$S.E_r$	$= \sigma/\sqrt{N}$	$S.E_u$	$= \sigma/\sqrt{N}$
	$= 10.4/\sqrt{600}$		$= 10.5/\sqrt{37}$
	$= \frac{10.4}{24.495}$		$= \frac{10}{6.083}$
	$= .43$		$= 1.74$

$$S.E.(M_u - M_r) = \sqrt{S.E_u^2 - S.E_r^2}$$

$$= \sqrt{1.74^2 - .43^2}$$

$$= \sqrt{3.0176 - .1849}$$

$$= \sqrt{3.2025}$$

$$= 1.7889$$

$$C.R. = \frac{\text{Diff. between the means}}{S.E.(M_u - M_r)}$$

$$= \frac{5.2}{1.7889} = 2.983$$

The

The following table shows the critical ratios for the differences between the means as found from Table No.XX.

Table No.XXI

Table showing the critical ratios for the differences between the means.

Standard.	Mean of Rural.	Mean of Urban.	Critical Ratio
3	22.4	26.9	2.18
4	35.9	42.3	3.23
5	46.4	51.4	2.88
6	53.7	60.2	3.17
7	59.8	65.0	2.98

From this table it is seen that in all the standards except the third the difference between the means is significant at the level of .05 as well as at the level of .01. In the case of the third standard it is significant signified at the level of only .05. since the critical ratio exceeds 1.96 but is less than 2.58.

The results of the above table are very significant for the teaching of arithmetic in the primary schools of the rural areas. This difference in theperformance is due to many reasons and the chief among them are described below.

The first and the foremost reason for the inferior achievement of the rural children is the fact that in rural areas

areas the teachers have to undertake a very difficult job of managing more than one class at a time. In school No.~~16~~ 17 (See Appendix III), the writer was surprised to find that the 7 classes were controlled by only two teachers, one of them was the head teacher who had to do a good deal of departmental correspondence besides. In school No. 11 one teacher was managing four classes. Under these conditions the teacher has to waste a great deal of his energy for maintaining order in the school and teaching is thrown into the back ground.

In the second place the children are badly ~~ma~~ equipped with the materials of instruction. A large number do not possess the text books and this leads to a very unprofitable use of the time on the part of the teacher however well-meaning the teacher may be. Even the teachers are not equipped with the concrete and semi-concrete materials required to clarify and fix the concepts of numbers.

The third factor of the bad performance of the children is the nonattendance in the rural schools. In most cases of the schools which were tested, I found that the attendance was less than 60 p.c. The children are occupied in helping their parents either in agriculture or in some other trade.

The final factor is the poverty of the student. Even the slightest expenditure incurred on education is a burden on the guardian and most guardians become apathetic regarding the education of the children. They simply do not care whether the child attends the school or not.

CHAPTER XII.

ANALYSIS OF TEST ITEMS.

The effectiveness of an item in a general achievement test depends upon two interrelated factors. They are: (1) The validity of the item from the point of view of the curriculum and (2) The discriminating power of the item.

In the first place the test item in a test must be valid for the measurement of specific objectives stated in the text books as well as the achievement of the objectives as they are stated for the course as a whole. The reason for this is that the children tested by the test will be examined on the basis of what they have been taught by their teachers.

If a test constructed on the above basis is found wanting under certain circumstances i.e. if the pupils in higher grades do not show a gradual rise in their scores then the blame must be placed upon the text books or upon the persons who are making use of them.

The test items in this test have been constructed so as to study the achievement of the objectives of arithmetic. viz., the application of the four rules to the computation by the four types of numbers:- (1) whole numbers; (2) fractions; (3) decimals; and (4) denominate numbers and their application to the solution of problems occurring in life like situations. This criterion of curricular validity applied to the test items

is seen

is seen to be perfectly satisfied as found in the rise in scores for the various standards. The norm score for standard 3 is 21, for standard 4, 36, for standard 5, 46, for standard 6 , 54 and for standard 7, 60. Thus the rise for the 3rd standard is 15 points, for the 4th standard 10 points, for the fifth standard 8 points, and for the sixth standard 6 points. It shows a gradual rise as the standards go on rising and the rise ismore rapid in the lower standards and less rapid for the higher standards.

In the second place a test item must discriminate. It must be able to separate the bright pupil from the dullard. 'The discriminating power of a test item refers to the degree to which the success or failure in the item indicates the possess--sion of the ability being measured. An item is to be positive in discriminating power when every pupil who scores successfully on the item ranks higher in the general ability scale than any pupil who fails in the item. An item is said to possess zero discriminating power when there is no systematic difference between the general ability of the pupils who succeed on the item and those who fail. An item is said to have a negative discriminating power when those who succeed in the item rank lower in the general ability scale than those who fail in the item'. This remark by Dr.Cook in his article on Achievement Tests in the Encyclopedia of Educational Research is noteworthy.

It sometimes happens that an apparently good test item possesses zero or negative discriminating power. On the other hand an apparently indifferent item possesses a positive discriminating

discriminating power which makes it a really good item for the test.

As defined above an item discriminates positively when the good students get the item right significantly more often than the poor students. Conversely if the poor students get the mark it right more often than the bright students then the item discriminates negatively. Hence the question that arises is x how great the difference between the bright students and the dull students should be to make the item good to be included in the test. It is very unfortunate thatthere is no very simple criterion which can be measured by the difference in the performances of the bright and the dull students.

A very good method can be developed for finding the discriminating power of an item by the use of the chart used for the analysis of errors (Vide Appendix V). The chart is prepared in the following way.

(1) The test papers are arranged in the descending order of merit. The paper with the highest score is placed at the top and the paper with the lowest score is placed at the bottom. This chart shows the analysis of addition for standard 6.

(2) The items solved incorrectly are marked by a cross and the items left out are marked by a dot as shown in the chart. The blank spaces will show the correct responses. If desired only the correct responses may be marked and the totals taken.

(3) The chart

(3) The chart is divided into two equal parts. In this case the dividing line is drawn below the 40th paper as the number of papers considered is 80. The upper half forms the group for the bright children and the lower half forms the group of the dull children.

(4) To find whether the test item is discriminating or not the percentage difference between the two groups is divided by the standard error of the difference between the percentages. The table on next page shows the results for the above chart.

The calculationsused in the chart are explained below by an example.

Let N_1 = Number of bright pupils giving the correct response.

X_1 = Total in the bright group.

P_1 = % marking item correct.

Q_1 = $1-P_1$ marking item incorrect.

N_2, X_2, P_2 and Q_2 are similar variables for the lower group.

As an illustration let an item be marked correctly by 32 in the upper group and by 20 in the lower group each group containing 40 children. Then

P_1 = 32/40 or 80%; Q_1 = 100 - 80 i.e. 20%

P_2 = 20/40 or 50%; Q_2 = 100 - 50 i.e. 50%

$$\text{S.E.diff.} = \sqrt{\frac{P_1Q_1}{X_1} - \frac{P_2Q_2}{X_2}}$$

$$= \sqrt{\frac{80 \times 20}{40} - \frac{50 \times 50}{40}}$$

$$= \sqrt{40 - 62.5}$$

$$= 10.1$$

$$\frac{P_1 - P_2}{\text{S.E. Diff.}} = \frac{30}{10.1} \text{ i.e. } 2.95$$

Table

Table No. XXII

Table showing the discrimination power for the items of additions for standard 6.

Item Number.	Right in Upper half.	Right in lower half.	Discriminating power.
1	40	39	.4
2	40	40	-
3	40	39	.4
4	40	37	1.7
5	39	36	1.8
6	39	36	1.8
7	40	38	.6
8	40	34	2.5
9	39	32	2.4
10	35	22	4.1
11	27	14	3.3
12	30	15	3.1
13	30	14	4.5
14	28	10	3.4
15	13	4	2.7
16	13	4	2.7
17	2	1	1.3
18	26	7	5.5
19	12	1	3.5
20	18	1	5.4

The above

The above table shows these coefficients of discrimination.

The following conclusions can be drawn from the above analysis.

(1) No item has a ~~k~~ negative discriminating power.

(2) The discriminating power of the easy items is small e.g. the first few items for this chart. This is so because these items are found to be easy for the 6th standard. Their discriminating power goes on increasing as the standard goes on decreasing.

As this is a test meant for 5½ standard, some items which would have a good positive discrimination for 2nd and 4th standard would not be so suitable for the higher standards and obviously the good items for the higher standards will have no discrimination forthe lower standards because the children of the lower standards would not be able to solve them. This will always be so in an achievemet or an intelligence examination. In this connection the following remarks of Dr. Cook in the Article referred to above is worth noting.

'Different ~~f~~elements in the achievement in a field may not be very highly related but each may still be an essential part of the whole field. Therefore item in one part may not be highly discriminating in the field as a whole, but still should be included in the test'. (6)

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(6) Encyclopedia of Educational Research. P.1294.

CHAPTER XIII.

SUGGESTIONS FOR THE IMPROVEMENT OF INSTRUCTION.

The results of a test are not of any value if they do not result in the improvement of learning of the children. The results of a test mmky reveal only the situation and the results must be used if the learning is to improve at all.

The results of testing can be used on four different levels. In the first place all the schools in a given locality can be tested and the results can be compared with the norms of the test. This will give information whether the locality as a whole is superior to, inferior to or on a par with the whole population, in their arithmetical ability.

On the second level the results of the tests can be applied to the performance of all the classes in each school. Some schools will be superior, others will be inferior and some will be equal in performance to that of the population. The schools which are found to be inferior should try to study their defects and improve them.

In order to study the deficiency of any school each class must be studied and the results must be compared with the norms. Both the age-norms and the grade-norms must be studied and the deficiencies of each class must be pointed out to the respective teachers. The teachers must then try to remove

the deficiencies

the deficiencies of the class by using suitable methods.

In order to profit by the study at the above three levels the study must be continued on the finallevel. This consists in studying the individual pupil. This must be done by studying the errors of individual pupils and each teacher concerned should devise a programme for removing the deficiencies of the pupils.

The above type of study will definitely reveal a large number of short-comings in the achievement of the children. These shortcomings may be due to any of the following five reasons.

Firstly the curriculum may be faulty. It may not be properly organised, its objectives may be limited to computa--tion alone; the gradation of the subject matter may be at fault; the content of the curriculum may be academic, formal and unrelated to the needs, interests and abilities of the children.

In the second place the instruction may make very little provision for the individual differences and may place emphasis on intensive drill rather than on meaningful practice. The teaching procedures themselves may be faulty and carried on unskillfully.

The third reason may lie in the text books and other materials of instruction. They may be too difficult as well as poorly constructed or arranged. The various processes may not be presented clearly and attractively and the contents may not be interesting.

Fourthly

Fourthly the social environment in and out of school may not be favourable to the learning. The attitude of the people especially in the rural areas may be unfavourable to the schooling of the children.

Finally the reason of unsatisfactory growth may be found in the student himself. The pupil's mental ability, his physical strength and physiological handicaps, his background of experiences, his methods of work and study, his interests, his attitudes his emotional and mental health may cause the inefficient performance of the child.

It is obvious that not all of these factors will be operative in a particular case. It is likely however that several of them may be contributing to the unsatisfactory condition. The most likely causes can be detected by the test.

The importance of testing in the improvement of instruc-tion is clearly brought out by Spitzer in the following quotation from his article 'Learning and Teaching Arithmetic' in 50th Year Book of The N.S.S.E.

"The use of tests in the Teaching of Arithmetic is an almost universal practice. From the beginning of instruction in this subject, the plan of "Teach (show), let the learner try or practice, and then find out how he is doing before teaching more or again" seems to have been used. At any rate 'Teach-Test-Teach" is in spite of much criticism still widely used. Even if teachers do not realise it that is actually

what is

what is involved in much of their teaching. Many would say that the preceding statement is a bit exaggerated. How practically all text books provide early in the book for each grade a series of exercises which are in fact, if not in name, tests designed to know what the child knows. As further evidence of the place of tests in the beginning of instruction, consider the following statement from a widely used book on the teaching of Arithmetic. "It is essential then, that the teacher begins the work of the year by studying individually the pupils of her class. The first step may well be the administration of a group achievement test".

Not only are tests used extensively at the beginning of a year's work but tests either in the form of everyday assignments or as regular test procedures are a part of instruc-tion in every phase of the subject. The errors and the lack of skill or knowledge revealed by tests are the basis for many of the explanations, demonstrations and suggestions which teachers use in instruction. Diagnosis of pupils achievement is an important aspect of teaching and should be recognised as such. The takingof a test, the location of errors, and the correction of the errors by the pupils are good learning experiences in themselves. Then, too, the use of the tests is a powerful motivating force. It is only when the time given to the tests becomes excessive and tests are used without other good instructions, procedures that tests become detrimental to teaching. Like drill or practice, tests have a secure place

in instruction

in instruction and neither abuse through over emphasis by incompetent teachers nor severe criticism by critics has done much towards removing tests from class room instruction."

The chief defect of the present system of teaching arithmetic is the use of the method of rote learning. This must be discarded. The method of developing understandings and meanings must be used. In this connection it is worthwhile noting the last paragraph of Wheal's Book "The Psychology and Teaching of Arithmetic".

"Counting is easy, and its application is easy, once it is learnt. Counting is not a natural endowment, however; it has to be taught. The number system is simple and its application is simplicity itself, once it is learnt. The number system is not a gift of nature, however, the number system must be taught. Both counting and the number system are not discoverable in the natural world; both are into the world as a means of setting it in order by a mind that has been trained." (7)

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(7) The Psychology and Teaching of Arithmetic. P.563-564.

Appendix I

अंकगणिताची कसोटी

(प्राथमिक वर्ग ३ ते ७)

— सूचना —

१) सुरवात करण्यास सांगेपर्यंत पान उलटूं नका.

२) एकंदर पांच कसोट्या आहेत. १ ली व २ री ला प्रत्येकी ७ मिनिटे, ३ री ४ थी ला प्रत्येकी ८ मिनिटे व ५ वी ला १० मिनिटे वेळ दिलेली आहे.

३) सुरवात करा असें सांगतांच पहिल्या कसोटीस सुरवात करा. वेळ संपताच इशारा दिला जाईल तावडतोब दुसऱ्या कसोटीस सुरवात करा. अशा प्रकारें कसोटी संपेपर्यंत गणीतें सोडवा.

४) गणितें सोडवित असतांना कोणताही प्रश्न विचारूं नये. एखादें गणित येत नसेल तर ते सोडून द्या व पुढचें गणित सोडवा.

५) अपुर्णांक अतिसंक्षेप रूपांत लिहा. विषम अपुर्णांक असल्यास पुर्णांक युक्त अपुर्णांक करा.

६) खालीं दिलेली माहिती भरा.

विद्यार्थ्याचें नांव _____

विद्यार्थ्याची जात _____ जन्म तारीख _____

वय _____ वर्षे _____ महिने

शाळेचें नांव _____

गांवाचें नांव _____ जिल्ह्याचें नांव _____

बाप अथवा पालकाचें नांव _____

बाप अथवा पालकाचा धंदा _____

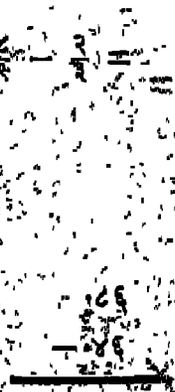
१० ११ १३ १७ ४० ४७
—२ —५ —८ —१४ —१६ —१५

३५ ४० ७६१ ९३७ ७५०८₁₆
—३४ —१७ —११२ —४८२ —८२९

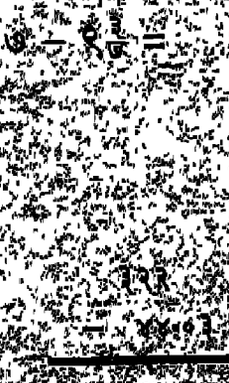
रु. आ. पै.
७—३—८
—२—११—१०

या. फू. इं
७—१—८
—३—३—१०

ता. मि. से.
३—१९—४०
—१—४०—५०







गुणाकार करा कसोटी ३ री वेळ ८ मिनि

३	४	६	७	४
×२	×१	×४	×५	×९

१३	१६	१७	५५०	
× ९	× ८	× ९	× ३७	×

रु. आ. पै	या. फू. इं.	ता. मि. से.
७--९--८	३--१--८	३--५०--४०
×१२	×१४	×

$२\frac{३}{२} \times \frac{४}{९} =$ $४ \times २\frac{७}{८} =$ $७\frac{१}{२} \times ५\frac{१}{३} =$

४	७.२९	
×.५	× १.८	×

कसोटी ४ थी. वेळ ८ मिनिटें.

३) १५ (६) ४२ (९) ७२ (

१४) २६४ (१८) ६५८ (४) ४३२ (

१७) ३५९ (७५) ३७५२५ (

या. फू. इं. ता. मि. से.

१५) ३७--२--१० (१२) २१--१०--३० (

$४\frac{३}{४} + ४२\frac{१}{२} =$ $७\frac{१}{२} + ५ =$

०६) १·४५२ (७) ९·४२ (

उदाहरणे सोडवा व जागेत उत्तरे लिहा.

१) रामजवळ ५ गोट्या आहेत व हरीजवळ ७ गोट्या आहेत, तर दोघांजवळ एकूण गोट्या किती ? [१]

२) माझ्याजवळ ४ आंबे आहेत व माझ्या भावाजवळ ९ आंबे आहेत, तर भावाजवळ किती आंबे अधिक आहेत ? [२]

३) आंबे, काजू व पेरू मिळून ४० फळे आहेत, ८ आंबे व १३ पेरू असल्यास काजू किती ? [३]

४) एका पिशवीत ६ नारळ राहतात तर ३० नारळांना किती पिशव्या लागतील ? [४]

५) गोविंदाजवळ २५ रु. आहेत त्याला ४५ रु. मिळाले. त्याच्याजवळ एकंदर रुपये किती ? [५]

६) प्रत्येक मुलाला ३ आणे प्रमाणे २० मुलांना किती रुपये व किती आणे लागतील ? [६]

७) माझ्या जवळ ४० रु. आहेत. प्रत्येकी ४ रु. प्रमाणे ७ मुलांना देऊन माझ्याजवळ किती शिल्लक राहतील ? [७]

८) एका पुस्तकाला ८ आणे या भावानें २४ पुस्तकांची किंमत काय ? [८]

९) एका वर्गात ३५ मुले आहेत प्रत्येकाजवळ ६ वह्या आहेत. वर्गात एकंदर वह्या किती ? [९]

१०) ४ रुपयांचे ३ सारखे भाग केले तर एका भागाची किंमत काय ? [१०]

वेळ १० मिनिटे

(११) आण्याला ८ या भावाने २४ बोरे विकत घेतली तर [११]
किती आणे पडतील ?

(१२) १९५० सालीं एका मुलाचें वय १५ वर्षे होतें तर तो [१२]
कोणत्या सालीं जन्मला ?

(१३) १ डझन पुस्तकानां ४ रु. ८ आणे पडतात तर १ [१३]
पुस्तकाची किंमत काय ?

(१४) हरीजवळ १ फू. ४ इं. दोरी आहे. सुरेशजवळ हरीच्या [१४]
चौपट लांब दोरी आहे. सुरेशच्या दोरीची लांबी किती ?

(१५) एका पिशवींत ४ पौंड साखर आहे. दुसरींत पहिलीहून [१५]
२ पौंड अधिक साखर आहे तर दोन्ही पिशव्यांत साखर
किती?

(१६) १ पुस्तकाची १४५ पानें तर २४ पुस्तकांची पानें किती? [१६]

(१७) १२ शर्टांना ४५ रु. पडतात तर १६ शर्टांची किंमत [१७]
काय ?

(१८) एका चौरसाकृती खोलीचें क्षेत्रफळ १६ चौ. पा. आहे [१८]
तर त्या खोलीची परिमिती काय ?

(१९) २ आणे डझन भावाने २८ नारंग्या विकत घेतल्या व [१९]
पैशाला एक या भावाने विकल्या तर एकंदर नफा किती ?

(२०) एका संख्येच्या पाऊण पटीतून तिची तिपाऊ वजा केली [२०]
तर १५ येतात तर मूळ संख्या कोणती ?

Appendix II

अंकगणिताची कसोटी

(प्राथमिक वर्ग १ ते ७)

— सूचना —

सुरवात करण्यास सांगेपर्यंत प्रश्न उलटू नका.

एकंदर पांच कसोट्या आहेत. १ ली व २ री ला प्रत्येकी ७ मिनिटे, ३ री ४ थी ला प्रत्येकी ८ मिनिटे व ५ वी ला १० मिनिटे वेळ दिलेली आहे.

सुरवात करा असे सांगताच पहिल्या कसोटीस सुरवात करा. वेळ संपताच इशारा दिला जाईल तावडतोब दुसऱ्या कसोटीस सुरवात करा. अशा प्रकारें कसोटी संपेपर्यंत गणितें सोडवा.

गणितें सोडवित असतांना कोणताही प्रश्न विचारू नये. एखादे गणित येत नसेल तर ते सोडून द्या व पुढचें गणित सोडवा.

अपुर्णांक अतिसंक्षेप रूपात लिहा. विषम अपुर्णांक असल्यास पुर्णांक युक्त अपुर्णांक करा.

खाली दिलेली माहिती भरा.

विद्यार्थ्याचें नांव _____

विद्यार्थ्याची जात _____ जन्म तारीख _____

वय _____ वर्षें _____ महिनें _____

शाळेचे नांव _____

गावाचे नांव _____ तालुक्याचे नांव _____

आपण अथवा पालकाचे नांव _____

आपण अथवा पालकाचा पत्ता _____

बेरीज करा　　कसोटी १ ली　　वेळ ७ मिनिटे

५	६	५	११	१८	५
+३	+४	+६	+ ४	+१६	+३
					+४

		५०८	४३०९	+ ४८
३६	३४	+४२३	+७१८३	+४६२
+२४	+२९	+७४७	+५९६४	+ ९३
				+ ३

रु. आ. पै	या. फू. इं.	ता. मि. से.
१५--४--७	४--१--९	४--१५--३०
+१३-१४--९	+३--२--७	+२--५०--४०

$७\frac{२}{८} + ७\frac{३}{८} =$　　$७\frac{१}{२} + ६\frac{१}{४} =$　　$७\frac{१}{४} + ४\frac{१}{३} + २\frac{१}{५} =$

७.२५	.४१	३.९२
+८.१४	+३.८	+७.५४
	+१.०१९	+२.७८

कसोटी २ री

वेळ ७ मिनिटें

२३ —१३	२७ —१४	४० —१६	४७ —२८

७६१ —११२	९३७ —४८२	७५०८ —८८३९

या. फू. इं. ७—१—८ —२—२—१०	ता. मि. से. ३—१९—४० —१—४०—५०

$५\frac{३}{८} - २\frac{३}{४} =$ $१७ - ९\frac{३}{७} =$

८·४८ २८·५५९	३२२ — ४४·०३

गुणाकार करा　　कसोटी ३ री　　वेळ ८ मिनिटे

३ ×२	४ ×३	६ ×४	७ ×५	४ ×९	१० ×४
१३ ×६	१६ ×८	१७ ×९	५५० ×३७	४०८७ ×५६	

रु. आ. पै	या. फू. इं.	ता. मि. से.
७--६--८ ×६	३--२--८ ×८	२--५०-४० ×९

$२\frac{३}{४} \times \frac{४}{९} =$　　$४ \times २\frac{७}{८} =$　　$७\frac{१}{२} \times ५\frac{१}{२} =$

४ ×०.५	७.२९ ×१०८	०४३ ×२५

कसोटी ४ थी — वेळ ८ मिनिटें

३) १५ ६) ४२ ९) ७२

१४) ३६४ १८) ६५८ ४) ४३२

१७) ३५९ ७५) ३७५२२५

या. फू. इं. ता. मि. से.

१५) २२--२--९ (१२) १५--१०--३६ (

$\frac{3}{4} + 4\frac{1}{10} =$ $7\frac{1}{2} + 5 =$

१०६) १०४५२ ( ) ५४०३६ (

उदाहरणे सोडवा व जागेत उत्तरे लिहा. कसोटी ५ वी

१) रामजवळ ५ गोट्या आहेत व हरीजवळ ७ गोट्या आहेत, तर दोघांजवळ एकूण गोट्या किती ? [१]

२) माझ्याजवळ ४ आंबे आहेत व माझ्या भावाजवळ ९ आंबे आहेत, तर भावाजवळ किती आंबे आधिक आहेत ? [२]

३) आंबे, काजू व पेरू मिळून ४० फळें आहेत, ८ आंबे व १३ पेरू असल्यास काजू किती ? [३]

४) एका पिशवींत ६ नारळ राहतात तर ३० नारळांना किती पिशव्या लागतील ? [४]

५) गोविंदाजवळ २५ रु. आहेत त्याला ४५ रु. मिळाले. त्याच्याजवळ एकंदर रुपये किती ? [५]

६) प्रत्यक मुलाला ३ आणे प्रमाणे २० मुलांनां किती रुपये व किती आणे लागतील ? [६]

७) माझ्या जवळ ४० रु. आहेत. प्रत्येकी ४ रु. प्रमाणे ७ मुलांनां देऊन माझ्या जवळ किती शिल्लक राहतील ? [७]

८) एका पुस्तकाला ८ आणे या भावान २४ पुस्तकांची किंमत काय ? [८]

९) एका वर्गात ३५ मुलें आहेत प्रत्येकाजवळ ६ वह्या आहेत. वर्गात एकंदर वह्या किती ? [९]

१०) ४ रुपयांचे ३ सारखे भाग केले तर एका भागाची किंमत काय ? [१०]

११) आण्याला ८ या भावाने २४ बेरे विकत घेतलीं तर [११]
किती आणे पडतील ?

१२) १९५० सालीं एका मुलाचें वय १५ वर्षे होतें तर तो [१२]
कोणत्या सालीं जन्मला ?

१३) १ डझन पुस्तकानां ४ रु. ८ आणे पडतात तर १ [१३]
पुस्तकाची किंमत काय ?

१४) हरीजवळ १ फू. ४ इं. दोरी आहे. सुरेशजवळ हरीच्या [१४]
चौपट लांब दोरी आहे. सुरेशच्या दोरीची लांबी किती ?

१५) एका पिशवींत ४ पौंड साखर आहे. दुसरीत पहिलीहून [१५]
२ पौंड अधिक साखर आहे तर दोन्ही पिशव्यांत साखर
किती?

१६) १ पुस्तकाची १४५ पानें तर २४ पुस्तकांची पानें किती? [१६]

१७) १२ शर्टांना ४५ रु. पडतात तर १६ शर्टांची किंमत [१७]
काय ?

१८) एका चौरसाकृती खोलीचें क्षेत्रफळ १६ चौ. या. आहे [१८]
तर त्या खोलीची परिमिती काय ?

१९) २ आणे डझन भावानें १८० गोट्या विकत घेतल्या व [१९]
पैशाला एक या भावानें विकल्या तर एकंदर नफा किती ?

२०) एका संख्येच्या पाऊण पटीतून तिची निमपट वजा केली [२०]
तर १५ येतात तर मूळ संख्या कोणती ?



महाराष्ट्र प्रिंटिंग वर्क्स, कोल्हापूर.

Appendix No. III.

Table showing the names of Villages and the number of pupils tested in each standard.

S.No.	Name of Village.	Standard.					Total.
		3	4	5	6	7	
1	Akurde	12	13	-	-	-	25
2	Alate	25	57	19	11	16	128
3	Aurwad	-	16	8	11	26	61
4	Bahubali	-	-	11	15	37	63
5	Chikhali	20	21	6	4	8	59
6	Gargoti(B)	36	18	40	57	53	204
7	Gargoti(G)	6	13	5	7	7	38
8	Ghunaki	33	27	14	17	10	101
9	Hamidwada	9	27	26	17	20	99
10	Hatkanangale	31	51	36	30	42	190
11	Herle	30	-	-	30	28	88
12	Kalnakwadi	7	4	-	-	-	11
13	Kaulge	23	10	10	3	9	55
14	Khadkewada	5	4	10	10	-	29
15	Khanapur	8	11	-	-	-	19
16	Kini	38	33	18	29	23	141
17	Koor	10	8	10	16	16	60
18	Korochi	-	20	2	8	-	30
19	Kumbhoj (B)	21	44	47	42	26	180
20	Kumbhoj (G)	32	11	7	7	10	67

S.No.	Name of village.	Standard.					Total.
		3	4	5	6	7	
21	Madilge(B)	16	31	40	13	22	122
22	Madilge(G)	4	8	-	-	-	12
23	Nandani(B)	88	82	62	31	39	302
24	Nandani (G)	31	13	10	-	-	54
25	Nartavde	-	13	17	10	9	49
26	Narsinhawadi(B)	24	15	24	10	6	79
27	Narsinhawadi(G)	17	17	14	4	10	62
28	Radhanagari	-	37	42	16	20	115
29	Rukadi	37	35	41	20	27	160
30	Saravde	26	12	15	13	17	83
31	Shengaon	23	15	28	19	20	105
32	Shirol(B)	48	52	54	66	43	263
33	Shirol(G)	35	38	11	9	8	101
34	Shirol (Rajaram Vidyalaya)	34	28	-	-	-	62
35	Shiroli	-	32	15	22	35	104
36	Sonali	11	21	-	-	-	32
37	Udgaon	28	28	20	13	13	74
	Total.	740	865	662	560	600	3427

(B) - Boys. (G) - Girls.

Appendix No. IV.

Table showing the Frequency of s errors.

Type.	Standard				
	3	4	5	6	7
Addition					
Combination	41.6	39.8	16.3	13.5	6.4
Carrying	40.0	31.4	21.6	20.9	10.3
Comp. Addition.	-	15.7	19.2	26.6	35.3
Fractions.	-	-	21.2	18.1	10.8
Decimals.	-	-	19.2	20.9	27.2
Miscellaneous	18.4	13.1	3.4	-	-
Subtraction.					
Combination.	38.8	29.2	13.6	7.3	7.5
Borrowing	54.3	43.5	25.3	13.1	12.5
Comp. Subtraction	-	15.1	20.2	20.7	27.5
Fractions.	-	2.0	35.8	48.6	37.6
Decimals.	-	-	-	10.3	15.8
Miscellaneous.	6.9	10.2	5.1	-	-
Multiplication.					
Combination.	74.3	71.6	34.6	24.1	19.6
Carrying.	13.6	11.7	5.2	3.2	2.7
Partial Products.	12.1	6.9	2.0	-	-
Comp. Multiplier.	-	9.8	12.9	15.6	12.5
Fractions.	-	-	12.9	10.8	24.4
Decimals.	-	-	32.4	46.2	40.8
Division.					
Combination.	89.1	86.3	48.8	36.3	33.3
Comp. Division.	-	-	9.9	17.2	31.1
Fractions.	-	-	28.9	25.0	19.5
Decimals.	-	-	12.9	21.5	16.1
Miscellaneous.	10.9	13.7	-	-	-

Appendix No. VI.

Bibliography.

A - List of Books on Statistics.

(1) Statistics in Psychology and Education by Garret.
(2) Applied General Statistics by Croxton and Crowden.
(3) Introduction to the Theory of Statistics by Yule and Kendall.
(4) Statistical Tables for Students of Education and Psychology by K. Hozlinger.

B - Books on Testing and Measurement.

(5) How to Measure in Education by Macall.
(6) Evaluation and Measurement by Remmers, and Gage.
(7) Measurement and Evaluation in Elementary Schools by H.A.Greene and Sorgensen.
(8) Measuremdt and Evaluation in Secondary Schools by H.A.Greene and Sorgensen.
(9) Work Book in the measurement in Education, by Greene.
(10) New Examiner by Ballard.
(11) New Type Tests by and their applications in Indian Schools by Menzel.

C - Methods of Teaching Etc.

(12) Teaching the essentials of Arithmetic by Ballard.
(13) S Psychology and Teaching of Arithmetic by Wheat.
(14) Teaching Children Arithmetic by Morton.
(15) How to make Arithmetic meaningful by Brueckner and Gross Mickle.
(16) Psychology of Arithmetic by Thorndike.
(17) 29th Yearbook of the N.S.S.E.
(18) 34th Yearbook of the N.S.S.E.
(19) 38th Yearbook of the N.S.S.E.
(20) 50th Yearbook of the N.S.S.E.